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CIVIL ENGINEERING

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Spring Floods Ravage New England
Turbulent Merrimack River Rushing by Moody Street Bridge, Lowell, Mass., During Record Runoff (See Page 301)

Volume 6 *Number* 5

MAY 1936

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Among Our Writers

M. N. Lipp graduated from the Massachusetts Institute of Technology in 1920. After 5 years of experience in highway work in Illinois, he served successively as chief draftsman of the sewer department and engineer of design and construction for Miami Beach. He became city engineer in November 1933.

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Harrison P. Eddy, Jr., graduated from Massachusetts Institute of Technology in 1917. After two years with the U. S. Naval Reserve Force, he went with the consulting firm of Metcalf and Eddy as assistant engineer on sanitary engineering works. Since 1926 he has been a member of the firm.

H. A. Van Norman has been connected with the Los Angeles Bureau of Water Works and Supply since 1907, with the exception of two years. In 1928 he became chief engineer and general manager of the bureau. In this capacity he supervised the Bouquet Canyon Reservoir project.

Charles S. Whitney holds a master's degree in civil engineering from Cornell University (1915). He has specialized in the design of concrete bridges and structural work for buildings—since 1922 in private practice. Mr. Whitney is the author of numerous technical articles in Society publications and elsewhere.

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J. M. Jeffries is a civil engineering graduate of Virginia Polytechnic Institute. He spent several years in railroad construction in Virginia, West Virginia, and Ohio before becoming active in explosives work. His highway construction experience includes projects both in the United States and in Mexico.

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May 1936

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CIVIL ENGINEERING

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Number 5

Some Data on Beach Protection Works

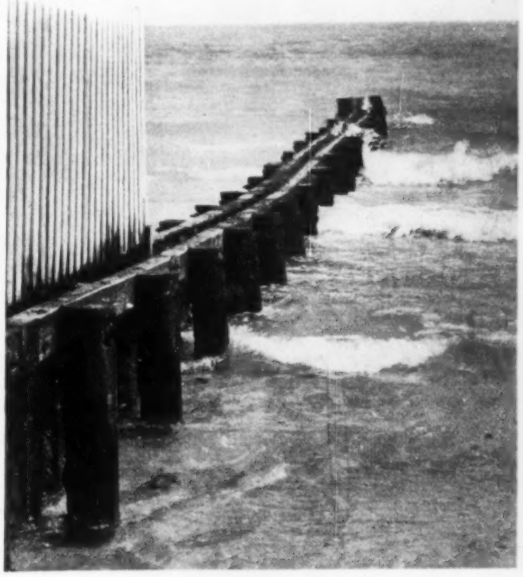
Importance of Adequate Groins Is Shown in Study of Existing Works on Florida East Coast

By M. N. Lipp
Associate Member American Society of Civil Engineers
City Engineer, Miami Beach, Fla.

Judging by the wide variety of types of beach protection works revealed during a survey of the 64-mile section of the Florida east coast between Miami Beach and Palm Beach, considerable difference of opinion exists as to the best design of groins and bulkheads, as well as to the relative advantages of steel, concrete, and wood construction. This article, abstracted from a paper delivered by Mr. Lipp on April 5, 1935, before the American Shore and Beach Preservation Association at Miami, gives the results of the study. In each case the investigator has noted the degree of deterioration that has taken place, and the efficiency of the design as indicated by the beach areas preserved or added. As a result of this study and of past experience, Mr. Lipp favors the use of steel sheet-pile bulkheads and groins. The latter, in his opinion, should have a length at least equal to two-thirds their lateral spacing, and should be braced with pretreated timber. The engineering problems involved in protection works design are too often neglected.

Florida can safely boast the most extensive beaches of any state in the country. In general, a blanket of sand overlies the coral rock on the ocean bed, but north of Boca Raton there are outcroppings of coquina rock, a beach deposit that has been consolidated by the solution and redeposition of calcium carbonate. The section between Miami Beach and Palm Beach (Fig. 1) is a narrow strip of sand beach, separated from the mainland by lagoons and continuous except for a few inlets connecting these lagoons with the ocean. The back-shore terraces and dune ridges are low at the southern and central part of Miami Beach and also at Hollywood, but elsewhere the sands rise abruptly from the water to a height of as much as 30 ft. Such a coast line offers an excellent opportunity for attack by the Atlantic, through the erosion of banks and the formation of inlets.

The sands which form these beaches, originating in the Piedmont and Appalachian Mountain regions of the southeastern states, are carried to the sea by several rivers, among them the Savannah. Shore currents and wave action cause the southward migration of the sands, constantly replenishing the sands on the Florida east coast. The supply is so great that these beaches as a whole cannot be destroyed, and the problem thus becomes one of stabilization. The fact that there is considerably more beach on the north side of the inlets than on the eroded south side, is proof of the direction of migration. Sands in this vicinity are composed of about equal parts of calcium carbonate and silica, the silica being the migratory material and the calcium carbonate the local shell admixture. The brown color of the Miami Beach sand is the result of high shell content. As we go northward the silica content increases, and the sands become whiter, finer, and firmer, all proof that the migration is southward. Although the prevailing winds are from the southeast, the wave action is stronger with the northeast winds, as it is not then impeded by the protective barrier of the Bahama Islands, which lie a comparatively short distance to the east. As regards strictly local action, there is some accretion from the south when the wind is from the southeast.



Southerly Groin, Miami Beach System, Showing Movement at End

When These Works Were Extended in 1930, the Sheeting at the Outer Ends Was Driven Into Rock

A one-day trip along the 64-mile coast line between Miami Beach and Palm Beach will reveal some interesting geological formations, which enter into our problems in the stabilization of beaches. The thing that is most apparent is the fact that deterioration of structures confronts us on all sides. Since many of these structures have been in place for a number of years, we can combine our experiences and observations to the end that better and more efficient works may be designed. It seems obvious that more study and thought should be given in the future to the problem of deterioration, and to the proper choice of types of structures and materials.

CONSTRUCTION OF MIAMI BEACH WORKS

Imposing granite jetties at the southern extremity of the city of Miami Beach protect the channel entrance to Miami harbor. The work here has been conducted by government engineers under the supervision of Lt. Col. George E. Brown. Besides serving its intended purpose, the north jetty is steadily building up an extensive beach for some distance to the north

The beach protection works constructed by the city of Miami Beach extend from 22d Street to 44th Street, a distance of 7,410 ft. The section from 22d Street to 33d Street was constructed in 1927, and the works were extended to 44th Street in 1930. Edward Neff, M. Am. Soc. C.E., was city engineer during the latter period, and Victor Gelineau, M. Am. Soc. C.E., was retained as consulting engineer for the original project in 1927.

TABLE I. MEASURED THICKNESSES OF STEEL SHEET PILING IN GROINS
Original Thickness Before Corrosion Was 0.407 In.

	1927 SECTION	1930 SECTION
Average maximum thickness........	0.380 in.	0.404 in.
Average minimum thickness........	0.322 in.	0.370 in.
General average thickness..........	0.351 in.	0.387 in.

The bulkhead consists of steel sheet piling, with the top at El. +8. It is anchored in such fashion as to resist wave action as well as backfill pressure. After studying wave heights reached during the 1926 storm, and walls capable of resisting forces occurring during such periods, it was decided to design a bulkhead to resist forces varying uniformly from 1,200 lb per sq ft at the top to zero at mean low water. Although such forces would be realized only during very infrequent storms, and then only after the sand in front was washed away, nevertheless it was decided to adopt these figures, as the small increase in cost was deemed good insurance against possible breaching by wave action or loose barges, with consequent damage to valuable property.

Groins at the southern end are generally 200 ft long, spaced approximately 300 ft apart, while those in the northern part are about 170 ft long and are spaced 250 ft apart, the length of the groins being two-thirds of the distance between them.

When the protection works were extended in 1930, the steel sheeting at the outer ends of the groins was driven into the rock in order to prevent it from settling and moving at these points. An insufficient amount of supporting sand, the result of eddies forming deep water, had caused some shifting in the previous works. The creosoted timber piles were all jetted and driven to rock. In future construction we intend to punch holes in the rock before driving the piles, in order to obtain a firmer hold. This method has been successfully used in Florida bridge work.

The steel placed in 1927 was treated with a bituminous preparation down to El. −2 and that placed in 1930 was given three applications of coal tar. The bituminous coating appeared to have the desirable qualities of adhesion and plasticity.

In order to determine the extent of the deterioration in the beach-protection works at Miami Beach, we recently made an extensive survey of our structures, measuring at regular intervals the web thicknesses of the steel at the pulling holes in the bulkhead sheets. The results of this investigation are shown in Table I. Since the original steel was 0.407 in. thick, these figures indicate that a loss of 14 per cent occurred over a period of eight years in the case of the 1927 construction, and a loss of 5 per cent in a five-year period for the 1930 works.

By digging into the sand we also determined that below the sand line the bulkhead is in practically the same condition as the day it was built. Since the beach has been built up to within a couple of feet of the top of the bulkhead, I cannot see any reason to be concerned over deterioration in the exposed parts. Eventually, when the steel is corroded to a point where its effectiveness is gone, we can dig down into the sand a short distance, cut off the steel, and replace it with an inexpensive concrete cap.

Although both kinds of bituminous bulkhead coatings have been sand-blasted off at exposed places, they do add somewhat to the life of the steel and, where not exposed, have remained intact and have assisted the protective action of the natural sand covering.

The groins and their component parts were also examined thoroughly. Practically no corrosion was found in the sheet piling. The protective coatings were generally found in good condition, with the bituminous preparation in better condition than the coal tar.

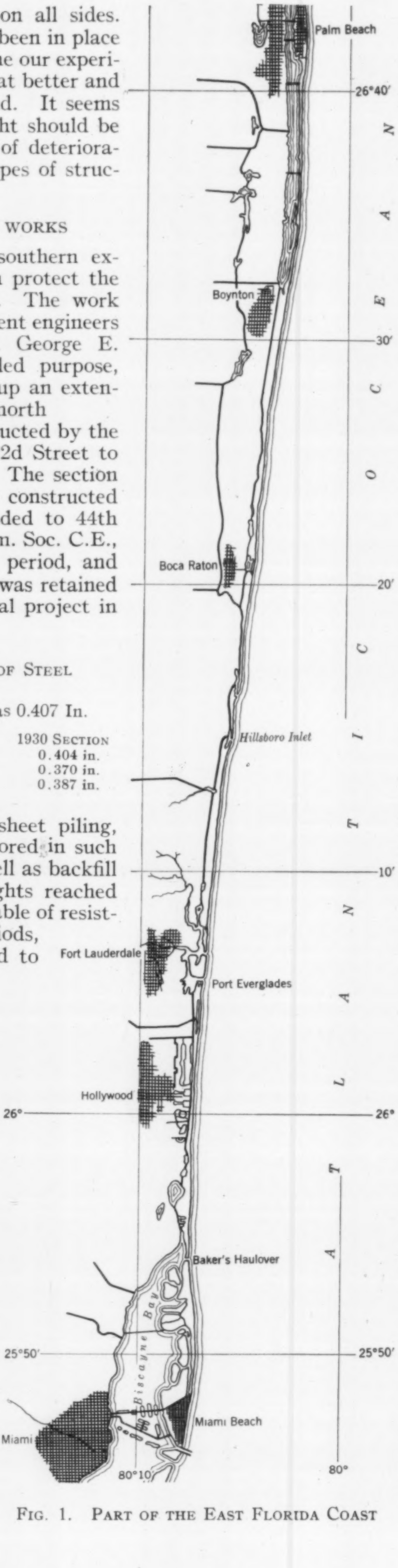


FIG. 1. PART OF THE EAST FLORIDA COAST

These groins are similar to the detail shown in Fig. 2. Inshore, where the beaches are built up, the steel is naturally protected by the sand. Seaward, where the steel is more exposed, it is not only protected in part by the original treatment but by barnacles and a conglomerate consisting of cemented sand and lime, which clings to the sheets. As the groins are low and stay damp practically the entire day, a thin film of water also adds to the protection. In a few isolated cases there has been some corrosion in plates and bolts. There has been no such erosion of the steel by the abrasive action of the sand as has been experienced at Baker's Haulover and from Boynton north to Palm Beach, and at low water only one small hole was detected in the flange of one sheet of the entire system.

MARINE BORERS SHORTEN LIFE OF GROIN BRACING

The principal troubles encountered with the groins arise from the action of marine borers in the creosoted waling and piles. Since these borers, chiefly the teredo, attack timber at the vertical interval between high water and the sand line, the troubles occur mainly at the outer ends of the groins. The attack begins through bolt holes and at the splices and ends of the wale timbers that were cut in the field. The piles show greater attack on the side toward the steel sheet piling. It is on this side that the borers enter the bolt holes, as large ogee washers prevent their entrance at the outer side.

In order to mitigate the attack of borers, I would strongly recommend (1) that all cutting of timbers and drilling of bolt holes be done before treatment, and (2) that cutting and drilling of timber below high water be absolutely avoided in the field, as the treatment during construction is usually of a careless nature, and even if done carefully, is but a temporary expedient. Where it is impossible to drill holes before treatment I believe some simple means can be devised to prevent the entrance of the borers. I feel certain that marine borers will successfully attack creosoted timber eventually, even though it be uncut. This is evidenced by their persistency and methods of attack, and the leaching of the creosote oil.

We have obtained excellent results in building up the beach, and at no time has there been any serious loss of beach within the area protected by the works. The distance from the bulkhead to low water averages about 90 ft, whereas, prior to the construction of the works, low water was generally at the rear of the present bulkhead line, and in some instances there were several feet of water at this location. At the groins, the beach slopes almost uniformly from El. +6 at the bulkhead to El. −6, and in some cases El. −10, at the extremities of the groins, steepening somewhat as it approaches the ends. The washouts around the ends of the groins are generally 50 ft in diameter. Parallel with the bulkhead and in line with the ends of the groins, the profile of the bottom is somewhat crescent-shaped, rising to as high as El. −2 to El. −4 midway between them. The beaches in front of the longer groins are somewhat more extensive, and partly because of the eddies I personally feel that the extent of the built-up beach will depend primarily upon the length of the groins if the proper attention is paid to the spacing between them.

GRAVITY-TYPE CONCRETE SEA WALL SOUTH OF BOYNTON INLET

During Storms the Curved Face of the Wall Is Effective in Turning Back the Seas

At 33d Street the bulkhead curves convexly in a northwesterly direction, and here the beach is not as satisfactory as at other places. Whether this is due to a change in alignment or merely to a coincidence, I am not certain. At the southern extremity of the works there has been some erosion, and it has proved necessary at times to construct temporary wooden groins to protect an ocean front street lying immediately south of the end of the bulkhead.

An interesting type of bulkhead designed by R. W. Reed, Assoc. M. Am. Soc. C.E., of Miami, has been constructed in front of a few private estates. Ordinarily

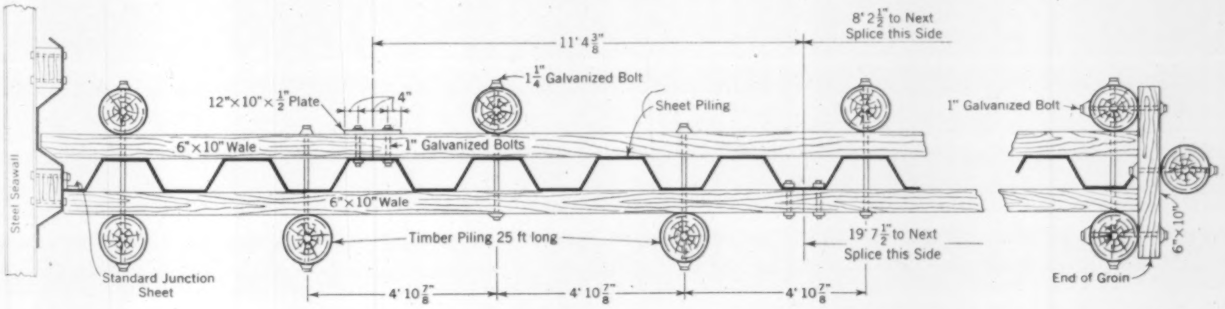
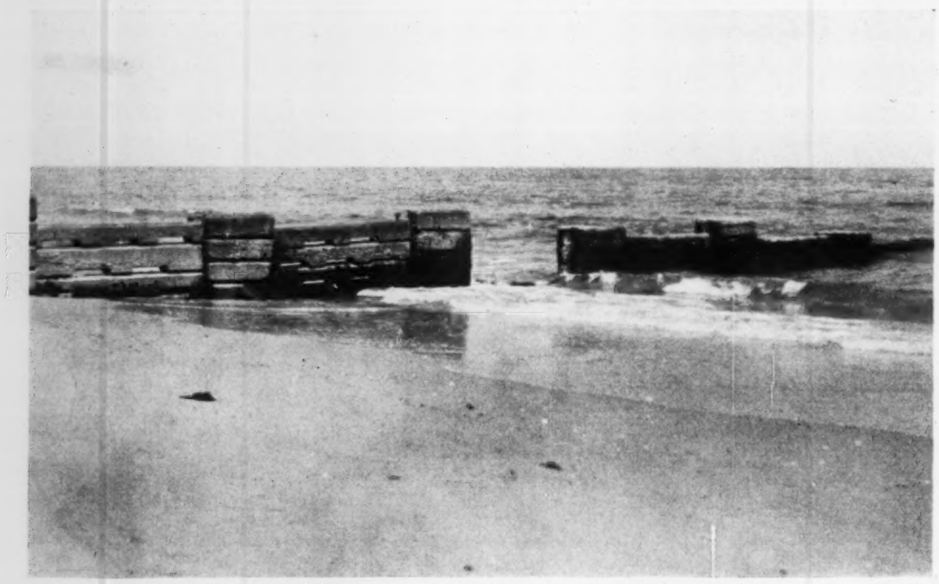


FIG. 2. DETAILS OF GROINS USED BY CITY OF MIAMI BEACH

referred to as a gunited type, this bulkhead consists essentially of the standard City of Miami Beach steel bulkhead with a concrete core within the arches of the sheet piling. Gunite, applied over the steel and the outside of the core, is reinforced by steel mesh, spot-welded to the steel sheeting. The face is straight to within a short distance of the top, where it is given a sharp outward curve to throw back spray and provide sufficient width for a walkway. This type of bulkhead has a pleasing appearance, and wherever I have examined it I have found it to be in excellent condition. However, it has not yet been subjected to much exposure or to any extensive battering by the waves, as the beaches are well built up.


Permeable Concrete Groin at Palm Beach
The Purpose of This Type Is to Provide a Uniform Beach

About seven years ago Mr. Reed designed a steel groin braced by gunited timber waling and gunited timber piles. All the bracing is in excellent condition today. The lower part of each pile was gunited before installation, and the part above water and the waling were gunited after driving. The fact that this groin is in excellent condition as far as I can determine from visual inspection, justifies further study and investigation of this type.

TYPES OF CONSTRUCTION AT POINTS FARTHER UP THE COAST

Baker's Haulover Inlet, which connects Biscayne Bay with the ocean a few miles north of Miami Beach, is protected by jetties. South of the inlet on the ocean there is a steel bulkhead system with very short steel groins which have no bracing whatever. These groins have not functioned satisfactorily because they are too short. Apparently there has been more corrosion in the exposed part of the steel bulkhead here than in the one at Miami Beach, presumably the result of more spray at this locality.

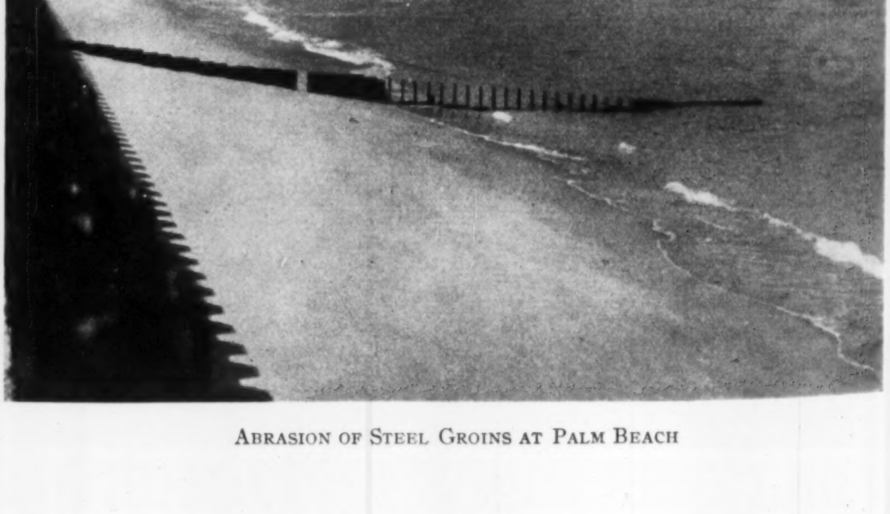
Here there is evidence of the abrasive action of the sand in eroding the steel in the groins. Generally the steel has been cut vertically in the flanges below the high-water line.

At Hollywood, Fla., a cantilevered bulkhead of steel sheet piling with a series of untreated timber groins protects an ocean frontage of over a thousand feet. The bulkhead was constructed in 1925 as a private enterprise, and the groins were built by the city in 1927. The hurricane of 1926 caused washouts around the ends of the bulkhead and destroyed a concrete walk immediately to the rear, but the bulkhead suffered no damage, although it has no anchorage system. There is no evidence of severe corrosion in the steel. Although only at El. +8, the top of the bulkhead has kinked slightly out of line in places, indicating the necessity for proper tie-backs. Marine borers have practically destroyed the groins with the result that a beach of only small extent remains.

SAND BARS BLOCK INLETS

At Hillsboro Inlet, a few miles north of Hollywood, there is an interesting formation of sand bars across the mouth, which is closing up its connection with the ocean. During stormy periods the sand bar is breached, but it closes up again at other times. Another point of interest is at Boynton Inlet, which is protected by jetties. Here also a sand bar is forming a short distance from the outer end, and the sand is carried back into the bay by the incoming tides. Although approximately 100,000 cu yd were dredged out of the bay a few years ago, it is rapidly filling up again.

A very short distance south of this inlet there is a protective system consisting of an excellent massive gravity-type curve-faced concrete sea wall, together with a series of variable-length groins. This system was designed by Zurwelle and Whitaker Company of Miami


Abrasion of Steel Groins at Palm Beach

Beach, associated with George M. Wisner of Chicago. The sea wall, which is approximately 2,000 ft in length, was constructed with its top at El. +15. The groins are of steel sheet piling with no bracing except T-sheets. As the sea wall is south of the inlet, the supply of sand is not as great as at points to the north. This particular location has to depend on local migration from the south and on whatever sand passes by the inlet from the north. However, more satisfactory results are being obtained between the longer groins than between the shorter ones, and this, I believe, indicates again the advantages of the longer groins. During heavy seas the curved face of the sea wall has been very effective in turning back the spray. Some abrasive action can be observed on the face of the concrete, while the steel in the groins is being eroded by the abrasive action of the sand, and in some places cut through. At the top many sheets have been beveled almost to a knife edge.

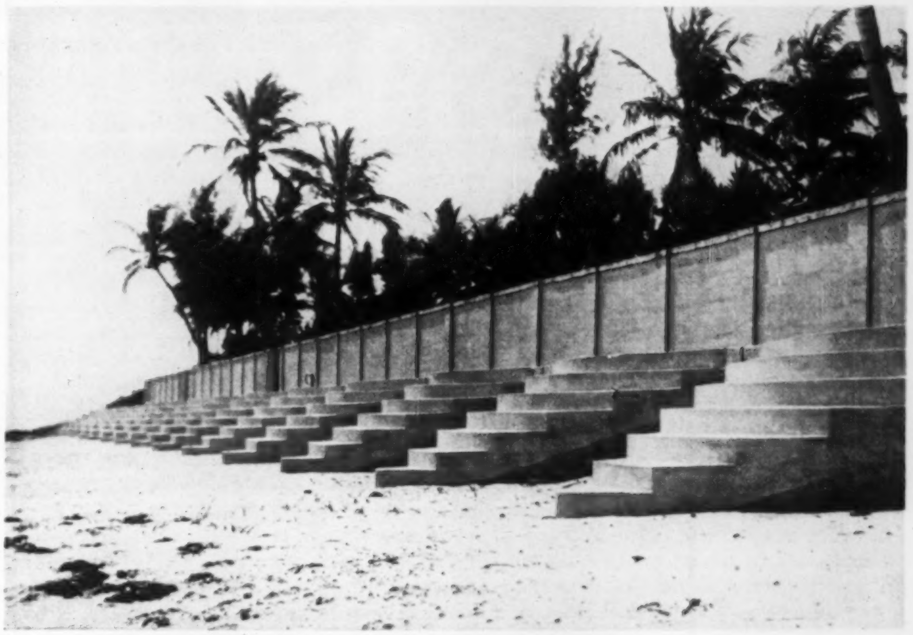
Five permeable concrete groins were constructed at Palm Beach in 1934 and 1935. The purpose of this type is to provide a uniform beach, but I believe that only the solid core wall, and not the permeable part, is effective. However, it is my understanding that the openings can be closed if desired. A few of the concrete beams have recently been battered out of position by the waves but can be replaced without difficulty. There are also some timber groins of the permeable type at Miami Beach, but from my observation these have not functioned nearly as well as the solid ones.

Since 1926 Palm Beach has endeavored to protect its ocean front by means of several types of bulkheads and groins. There the back-shore terrace and dune ridges are higher, and the surf stronger and of greater duration than at Miami Beach. Steel and creosoted timber bulkheads and steel and untreated timber groins have been used. Generally, the bulkheads have withstood the elements satisfactorily. In several places the necessary correlation of groins with bulkheads is lacking. Where groins have been built, difficulties are now being encountered, as the untreated timber used in the earliest construction has been practically destroyed by the teredo. Prior to their destruction, the groins built up an excellent beach, but its extent has since been greatly diminished. The steel groins that were constructed in the period from 1928 to 1930 have been severely eroded in places by the abrasive action of the sands.

A few years ago Palm Beach adopted, after comprehensive surveys, an ordinance which establishes bulkhead lines and groin locations and lengths. The City of Miami Beach has no such ordinance.

SOME IMPORTANT CONSIDERATIONS IN DESIGN

Much has been said and written about the corrosion of steel reinforcement in southern Florida. We know that poor and porous concrete in the past has contributed to the difficulty, but I am certain that we have not as yet obtained a permanent reinforced concrete, although newer methods and the broader education of engineers, architects, and contractors are insuring a better and denser product. However, it can safely be said that no construction material is permanent under all conditions. Once corrosion of the steel begins to spall the concrete, maintenance costs run high. I am convinced that the use of reinforced concrete will be found to be limited in sea-wall and bulkhead construction if an analysis is made which takes into account the items of initial cost, maintenance, probable life, and appearance. For use in groins, its lack of elasticity to withstand wave action should be given serious thought.



Step-Type Sea Wall near Boynton Inlet

I am convinced that groin construction is the root of the beach-protection problem. Satisfactory groins will build up a beach serving many purposes, including prevention of deterioration in the covered parts of bulkheads and groins, the protection of bulkheads and sea walls from abrasion during ordinary times, and elimination of the spray nuisance. Where expense has been incurred to secure attractiveness in a sea wall, it will probably be discovered that such expenditure has been needless, as the beauty of the wall is completely buried. Taking into consideration the important element of time, the sand in front of the sea wall will provide some protection during the infrequent storms of hurricane intensity.

With regard to steel groins, I believe an inexpensive timber sheeting encasement, either treated or untreated—whichever in the long run proves the cheaper—will best protect the steel from abrasive action. The timber itself will be subject to abrasion, but the groins should be so constructed that the sheeting can be renewed when necessary. In this type of construction I would be inclined not only to specify a first-class protective treatment for the steel but also to leave the top open in order that the steel might be kept wet and thus to some extent protected from corrosion.

Along the coast line between Miami Beach and Palm Beach there are many kinds of difficulties to be overcome. In projects involving vast expenditures of money, such as the protection of beaches, I feel that simple solutions for all our present problems will be found if proper advantage is taken of past experience, if existing structures are closely observed, and if practical application is made of the fundamental principles of the exact sciences.

Most of Our Large Cities Just Grow

But Advanced Planning Methods Make the Borough of Queens, New York City, an Exception

By CHARLES U. POWELL

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

ENGINEER IN CHARGE, TOPOGRAPHICAL BUREAU, BOROUGH OF QUEENS, NEW YORK, N.Y.

CAN a municipality lay out undeveloped private lands and force the owners to conform to such a design? The answer is "yes" in the case of the City of New York at least, where such prerogative has been clear for the past twenty years. In pursuance of this authority, the Borough of Queens will soon complete the planning, laying out, and developing of the 75,000 acres within its boundaries. The construction since 1921 of an extensive system of parkways at a cost of approximately $25,000,000 forms an important part of the work. In the following article Mr. Powell describes some of the practical aspects of the planned development referred to, which was successful because its sponsors possessed unusual ability to foresee future needs as well as the necessary engineering knowledge, financial backing, and legal authority.

A RECENT study of the planning methods pursued in cities of the United States with populations of 200,000 or more showed that about three out of four depend upon real estate developers to lay out undeveloped areas. In most such cases, the municipalities supervise the arrangements only in the sketchiest manner.

There is no law to stop a man from building his house as unhandy, unlovely, and illogically arranged as he pleases as long as the local building codes are observed and a reasonable degree of structural safety and fire resistance is secured. This is true of most of our cities also. The only requirement seems to be that the real estate developer's map show streets of a width adequate for local traffic. In many cases it is a matter of complete indifference whether the map ties in with maps of other developments (similarly prepared) lying on either side. In others, no legal authority exists to compel the developer to conform with any broadly conceived plan which may (but usually does not) exist.

It is an old story that Broadway, New York, was originally a cow path; Pearl Street must have been another. Washington Irving in his *Knickerbocker History* tells about this, and points the finger of scorn at that method of planning. Long afterward he was one of the most active spirits in the movement which led the city, before the Civil War, to acquire the lands now developed as Central Park. He saw the importance of doing real planning before it should be too late. Any real planning requires vision.

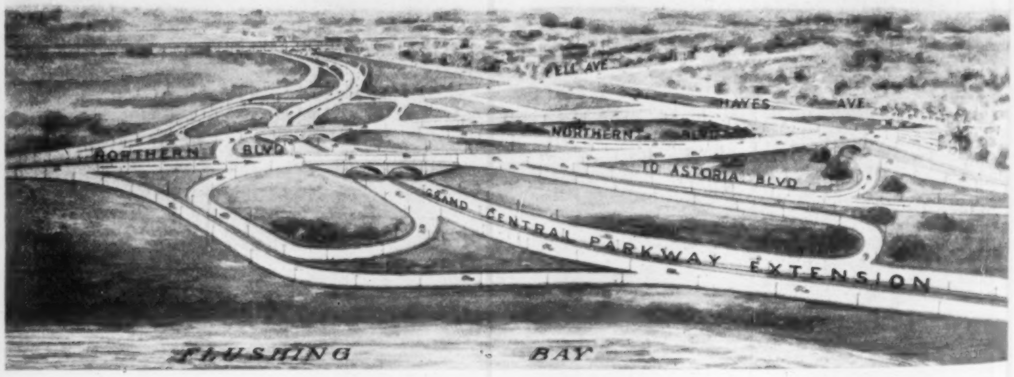
Every now and then one of our large cities, spurred by some public-spirited citizen, establishes a city planning commission, usually to do but one specific thing—to plan a newly annexed area, to throw a superhighway across a congested region, to coordinate facilities of one sort or another, or to consolidate a number of the city's activities and direct them more effectively. Once this task is accomplished, the commission usually disappears.

But effective city planning has many angles. It does not stop with clearing slums, beautifying the banks of a contiguous river, locating a civic center, or extending a rapid-transit line. It does not consist merely in drawing a map of some desirable improvement nor yet in broadening an existing artery into a spacious parkway. It includes much more than this.

SOME NON-ENGINEERING PROBLEMS ENCOUNTERED

Before planning on paper can be translated into fact, many problems must be solved which are not, strictly speaking, of an engineering nature. Whence will the money come that will be needed to pay for acquisition of the needed land and for the contemplated improvements? What legal authority exists for validating and executing the engineer's plans? How can the work be brought to a conclusion such that the project does not remain forever a mere hopeful desire? Frequently these hurdles are more difficult to negotiate than the engineering difficulties, and the engineer engaged in city planning must be on the alert continually to overcome such obstacles.

Such non-engineering matters as these have hindered the engineering staffs of a great many American cities. No matter how talented or efficient it may be, no engineering staff can accomplish much unless it has authority to carry out its plans. And it is just this lack of adequate authority which stands squarely across the path and hampers most of our cities in their efforts to better them-



PERSPECTIVE OF JUNCTION OF GRAND CENTRAL PARKWAY EXTENSION, NORTHERN BOULEVARD, AND ASTORIA AVENUE

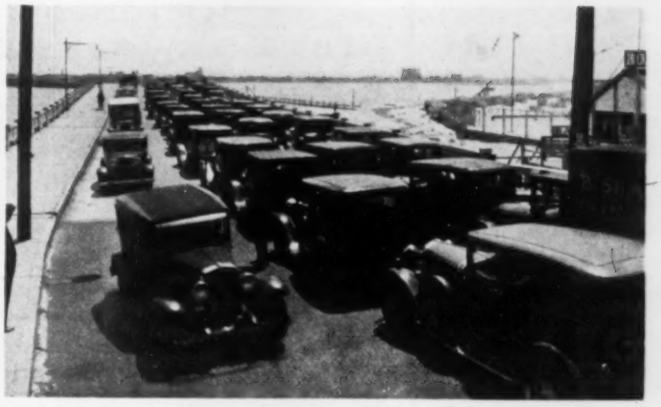
This So-Called "Pretzel" Grade Separation, with Its Three Bridges, Assures Uninterrupted Traffic Flow selves. Money is only part of the story. Even when the necessary funds are available, lack of authority to go ahead may defeat the whole purpose.

Suppose a city's charter provides, among many other things, for complete mapping of its entire area, including that still wholly undeveloped as well as that occupied by streets, houses, stores, and factories. It may be farms, woodlands, or swampy areas. It may be hills and gorges, lush meadows, or sandy beaches. Obviously the mapping of such areas long in advance of their contemplated use is a matter of engineering design. It is an integral and important part of city planning, but not many cities are organized to handle it.

All this undeveloped land is owned by individuals or corporations. Can a city, as a municipal entity, go ahead and lay out such lands with any assurance that its design will stand? Can it defend such a design in a court of law and force the owners to conform thereto? The answer is that it can if its set-up is arranged that way. While it cannot force owners to develop their land, it can prevent them from developing the land in any way that would do violence to the adopted city plan.

Only one of the large cities in the United States has full authority to go ahead on such a basis, as far as I have been able to ascertain. This city maintains continuously a full staff of engineers under civil service to see that the city plan is followed. It will surprise many to learn that the city referred to is both the largest and the oldest of all our large cities—New York.

The charter whereby greater New York City was formed in 1897 consolidated several cities, villages, and hamlets. The largest of these cities (also at that time the largest in America) had been founded in 1623 as New Amsterdam, antedating Boston by seven years, and Philadelphia and Baltimore by many more. The charter was revised in 1901. It has had many subsequent amendments, but none of these has changed the city planning functions and powers unless to strengthen them. Chapter 439 of the 1901 charter provides that areas not already mapped and accepted in such a manner that condemnation proceedings can be based on the maps, shall be so mapped, and lays down rules for the mapping work. Chapter 442 provides means for the official validation of maps so made, which thus become a part of the legal city plan, and the basis, in law, for all public improvements.



BOUND FOR THE SHORE, 1:45 P.M. ON A SATURDAY
Traffic Congestion on Jamaica Bay Boulevard. The Wide Parkways and Elaborate Grade Separations Are Designed to Prevent Such Conditions

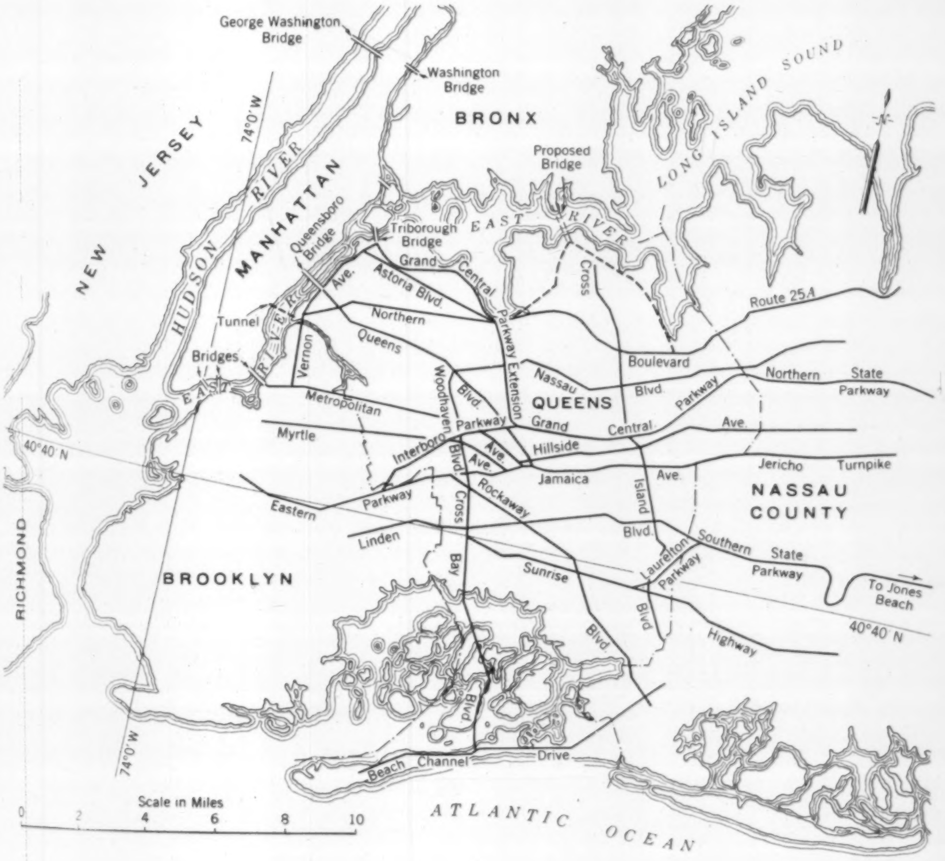

George Washington Bridge
Washington Bridge
BRONX
LONG ISLAND SOUND
NEW JERSEY
74°0' W
HUDSON RIVER
MANHATTAN
Queensboro Bridge
Proposed Bridge
Triborough Bridge
EAST RIVER
Grand
Central
Astoria Blvd
Ave.
Northern
Cross
Route 25A
Tunnel
Vernon
Queens
Parkway Extension
Boulevard
Bridges
EAST RIVER
Metropolitan
Woodhaven
Blvd.
Nassau
Blvd
QUEENS
Northern
State Parkway
Parkway
Grand
Central
Parkway
Ave.
Myrtle
40°40' N
Interboro
Ave.
Hillside
Blvd
Ave.
Jamaica
Ave.
Jericho
Turnpike
Rockaway
Island
NASSAU COUNTY
Eastern
Parkway
Cross
Linden
Blvd.
Southern
State
Parkway
Bay
Sunrise
Laurelton Parkway
Blvd
RICHMOND
BROOKLYN
To Jones Beach
40°40' N
Blvd.
Highway
Blvd
74°0' W
Beach Channel Drive
Scale in Miles
0 2 4 6 8 10
ATLANTIC OCEAN

FIG. 1. BOROUGH OF QUEENS AND CONTIGUOUS TERRITORY
Showing Borough Portions of Through Routes from Brooklyn, Manhattan, and the Bronx to the Beach Resorts and Country Clubs of Eastern Long Island

NEW YORK CITY'S PLANNING POWERS BROADENED

Until 1916 it was possible for a builder or real estate developer to ignore the city plan in areas where the city had not yet taken title to the streets shown thereon. This handicap to making the plan fully effective in practice was removed by the New York State Legislature in Chapter 513 of the laws of 1916, later clarified and strengthened by Chapter 620 of the laws of 1926. This provides, substantially, that no subdivision map may be filed or recorded which does not conform with the officially adopted city plan. In practice, this means that building lots cannot be sold by developers unless the streets in the development are in accordance with the city plan.

With these powers written into the city's corporate charter, practically all the undeveloped areas throughout New York City have now been mapped. These maps have received the approval of the Board of Estimate and Apportionment (the city's active

GRAND CENTRAL PARKWAY, LOOKING EAST AT PARSONS BOULEVARD

The Parkway Is 150 Ft Wide at This, Its Narrowest Point. Most of the Right of Way Is Now 330 Ft Wide. The Planned Minimum for Streets Is 60 Ft. Note the Landscaping and the Rustic Light Standards

legislative body), and are thus parts of an official plan for the whole area.

Of course districts already long settled had to remain as they were. Streets could be widened and a much-needed artery occasionally thrown across the grid of existing streets and avenues. But the building condemnation involved was too expensive for such work to be done in more than a few urgent cases. It was thus the outlying sections or areas which profited most from the powers given the city by the enactments referred to. Furthermore, it was the exercise of such powers in the orderly development of those outlying and semi-rural areas that made them desirable residential areas for the dense population of Manhattan, the central core of the greater city. Largely as a result of this movement, Manhattan lost almost 500,000 inhabitants between the years 1910 and 1930. During this period the population of Queens, largest of the outlying areas, increased by 800,000. The Bronx experienced a similar gain, while Brooklyn added more than 900,000 inhabitants in those twenty years.

The case of Queens Borough is typical of the way in which planning was done. Queens contains 117 sq miles of area, or about 39 per cent of the entire 300 sq miles of greater New York. In 1900, two years after the consolidation of those 300 sq miles into one municipality, Queens had 153,000 people, or $4^1/_2$ per cent of the city's 3,437,000. More than one-third of the 153,000 lived in Long Island City; the others were scattered in fifty-odd towns and villages, and on a number of farms.

Queens had then only 1,330 people to the square mile. The rest of New York had an average of 24,000 to the square mile, with the exception of Staten Island, which for geographic reasons has not kept pace with the remainder of the city. The relative opportunities for growth are thus evident. By 1930 Queens had 1,079,000 people, over 9,200 to the square mile. This is more than 12 per cent of the city's aggregate, or nearly three times the ratio shown in 1900. Manhattan, Brooklyn, and the Bronx had 5,693,000, or 42,500 on each square mile. In 30 years Queens thus showed a gain of 605 per cent; the other boroughs, a gain of 77 per cent.

COORDINATION OF QUEENS VILLAGES PRESENTED DIFFICULTIES

The streets and lots in each of the fifty-odd villages in Queens in 1900 had doubtless been laid out by real estate men and their private surveyors, engaged in subdividing erstwhile farms or other large holdings. Each one, considered by itself alone, may have been fully adequate as a design in the horse-and-buggy days in which it evolved. They later grew a bit here, another bit there, as new families moved in or the young people married and set up their own lares and penates. But here arises an obstacle to unified city planning—none of them was tied in at all with its neighbors on either side. The scattered villages were connected by roads meandering through intervening farming areas. The streets in one made sharp and awkward angles with those in the next. Most of the streets were narrow, even for the days when the automobile was a novelty and eight miles an hour was the legal speed limit.

Hence the problem of applying city planning to the broad reaches of Queens Borough was a difficult one. The borough is about 13 miles wide from the East River across to Nassau County, and nearly 15 miles long from Long Island Sound south to the Atlantic, as shown in Fig. 1. East and west across the center lies the backbone of Long Island, reaching about 260 ft above sea level a little before it enters Nassau County. North, nothwest, and south the land drops to tidewater. Great areas are so low as to be swampy, particularly along the shores of Jamaica Bay, in the south.

I believe that the city planning work which the Queens

TIRES
PRICES
SUIT YOU
GER & CLAIR
ESTABLISHED 15 YEARS
DEMOCRA
20 CARS PAINTED 20

Traffic Jams Occur During the Week Too

View on Northern Boulevard, East of Flushing Bridge, at 2:30 p.m. on a Monday. The Buildings at the Right Have Been Demolished and the Street Widened to 175 Ft Between Property Lines, with Grade Separations Where Necessary

Topographical Bureau performed on the Queens area is the greatest task of its kind ever carried through into construction anywhere in the world, and that even Baron Haussmann in Paris and Major l'Enfant in Washington produced far less in scope.

After a complete topographic map of the entire area had been obtained, a tentative design for the ultimate layout was made. In making this tentative map first consideration had to be given to the built-up villages scattered throughout the borough. Discordant features had to be worked into the unified design as best they could. It was a case of making the best showing possible out of a difficult tangle. The map was then adopted or legalized by the Board of Estimate.

Using this tentative map as a basis, the area was attacked piecemeal in units 4,000 ft square (367 acres). Figure 2 reproduces a subsection 1,000 ft square, taken from Section 131 of the final maps, showing a part of the Grand Central Parkway near Jamaica, N.Y. These resulting final map sections fit together like the squares on a checkerboard. The first sections were made for regions already largely settled. One section after another was added, and the mapped area was extended gradually into localities under active development. This work is still being carried on. Three final sections were legalized by the Board of Estimate on June 14, 1935, and at present more than 85 per cent of Queens is thus mapped. Only a few unmapped areas remain, mostly in the unsettled swampy region or along the hills in the northeastern part of the borough.

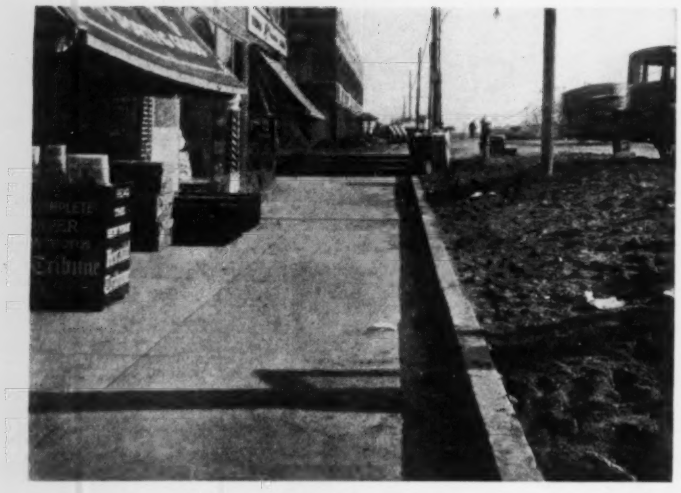
These final map sections form the legal basis for all land condemnation proceedings for any public purpose. The law requires that before the city can spend public money on permanent paving or on detailed sewer work, the final map sections involved must be prepared and officially approved, thus carrying out the mandate contained in the city's charter.

Every block within the limits of a final map section is laid out precisely. Lengths of block lines are given to the nearest hundredth of a foot; angles made by block lines are shown to the tenth of a second; and the whole is tied to a comprehensive set of stone monuments located by coordinates to the thousandth of a foot. This framework of monument lines spreading across the map like a spider web is the court of last resort in all matters affecting block and lot lines, land titles, and the like.

Along with this platting has gone leveling work. Benchmarks have been established throughout the area, and their elevations above the datum plane have been determined to the thousandth of a foot. All street elevations are established with reference to these bench marks. Elevations are shown at all street intersections, and at other places where a change of grade occurs or is to occur.

In laying out new territory elevations and grades must be carefully worked out. Sewers will be installed some day, and streets must have the grades required to drain to these sewers and sufficient elevation to provide for the necessary fill or "cover" over them. At the same time, existing topography must be followed rather closely in order to avoid heavy expense later in filling low lands or cutting down high places.

Here again, private developers have proved "bad actors" in many instances. Wherever they have built a row of houses without regard to legally established grades, and later sold them to people having no knowledge of the infraction, they have caused the buyers trouble. Houses built below the mapped street level are often subject to flooding of the cellars when the street is brought to grade. In other places, where the final street surface, as mapped before the houses were built, is to be much lower than the original dirt road, houses built "regardless" have later found themselves perched high above the street—in one case, 35 ft above!



A RESULT OF BUILDING BELOW THE ESTABLISHED STREET GRADE
The Street Level Was Later Lowered to Correct the Condition Shown, but Often This Cannot Be Done Without Damaging Other Properties

But there was another quality required in the planning work beside a knowledge of engineering with an admixture of law. That quality was vision. The automobile era was developing, and the time was not far distant when great arterial highways would be needed to carry high-speed traffic long distances without the customary vexatious delays at too-frequent street intersections. Everyone recognizes that problem and knows all about it today, but twenty years ago such was not the case.

It took a great deal of persuasion to get Grand Central Parkway down on the map in 1912, for we proposed to give it the immense width of 150 ft. As finally put into service, in 1933, most of the right of way is now 330 ft wide, and some of it is over 500 ft. It is interesting to note that few of the streets of Paris today are as much as 60 ft wide, which is our planned minimum.

When the Triborough Bridge was proposed, to connect Queens with both Manhattan and the Bronx, we came forward with a ready-made plan (as shown in Fig. 1) for taking away the traffic and passing it, without a red light or a crossing at grade, all the way over into Nassau County, almost 20 miles away. When the bridge and the rest of the route is opened late in 1936, that dream will be a reality. But the plan would not have been ready had we not looked ahead into the future many years before.

We have studies already made for taking traffic away from our end of another proposed bridge across the East River, from Malba to Old Ferry Point. This structure would have a clear span of 1,900 ft, a span exceeded nowhere in the world except by the George Washington Bridge, with its 3,500 ft, and by two bridges now under construction at San Francisco. This bridge may not be built for another dozen years or more.

There is another very necessary element in city planning. Public interest must be aroused. Unless there is some impetus back of them, the most elaborate designs will be futile. Owners of property and others must be made to see that execution of the proposed plans will be of advantage to everyone. The facilities proposed must be shown to be valuable enough to them to justify their acceptance of the added tax or assessment burden involved. Accordingly, the cooperation of the local press must be sought. Neighborhood meetings must be addressed, using pictures to show what the change will mean. Civic organizations, women's clubs, and political clubs must be urged to actively support the project made possible by the vision of engineers. All these means, and more, have gone into making Queens Borough an integral part of the New York City Plan.

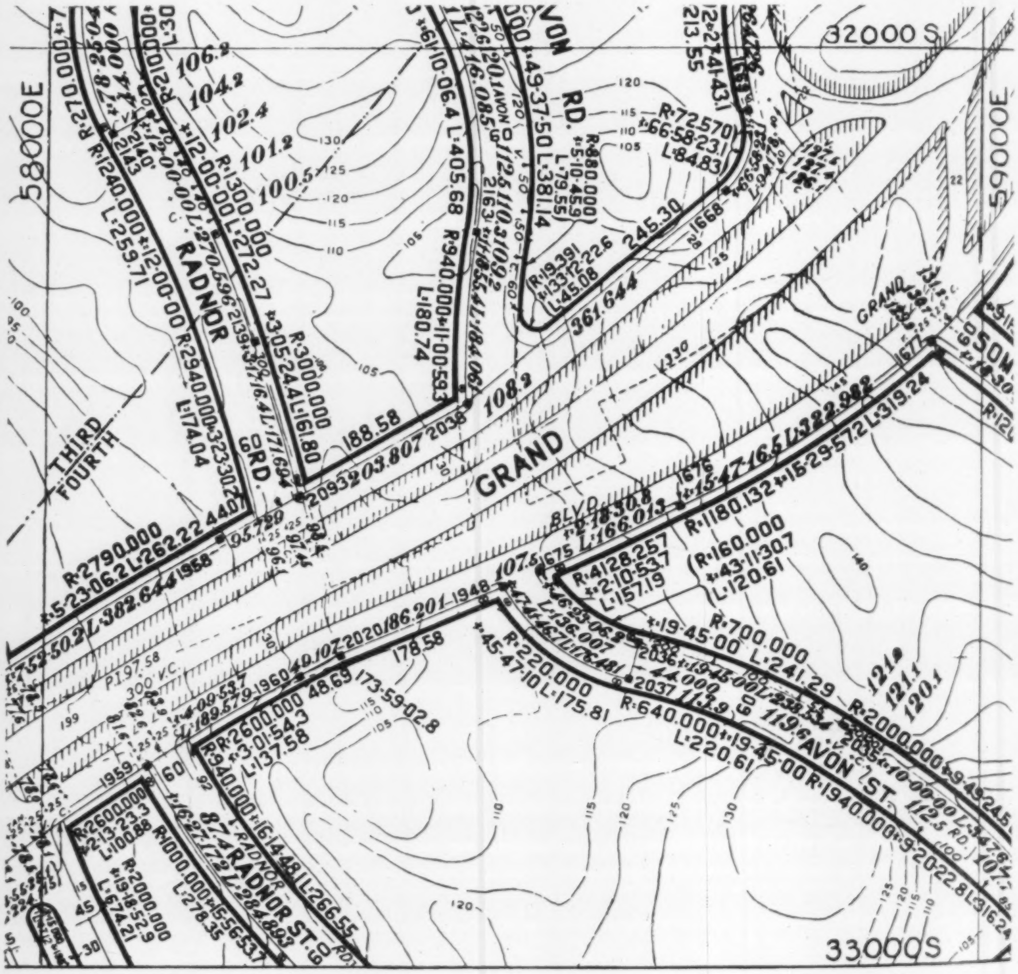


FIG. 2. SUBSECTION FROM ONE OF THE FINAL MAPS OF QUEENS BOROUGH, TAKEN NEAR JAMAICA, N.Y.
There Are About 200 Final Map Sections, Each Containing 16 Subsections Similar to That Shown. These Maps Form the Official and Legal Basis for All Public Improvements

New England Floods of 1936

Startling Early Records of Phenomenal Runoff Causing Unheard-of Flows, Heights, and Damage

By Harrison P. Eddy, Jr.
Member American Society of Civil Engineers
Metcalf and Eddy, Consulting Engineers, Boston, Mass.

Faced with a catastrophe of major proportions and of wide extent, such as the spring floods of 1936, the engineer's first thought is of protection and salvage. The emergency having been met, his next care is for the collection and preservation of valuable records, which after intensive study will serve in formulating corrective measures. Fortunately such records have been secured.

Those for New England, perhaps typical of the entire northeastern section of the country, are here digested and summarized. They show severe rainfall augmented by heavy snow runoff, aggregating unprecedented amounts, with resulting tremendous flood flows and heights that dwarf any previous known record for this section, already rich in hydraulic data. In presenting these for the immediate information of engineers, Mr. Eddy emphasizes the fact that some of the records have been secured from operating engineers who were more concerned at the time in saving property and life than with strict accuracy in their computations. This information must accordingly be considered tentative and subject to later correction. Engineers therefore should not use these data after more accurate records become available, such as the special report on this flood under preparation by the U. S. Geological Survey.

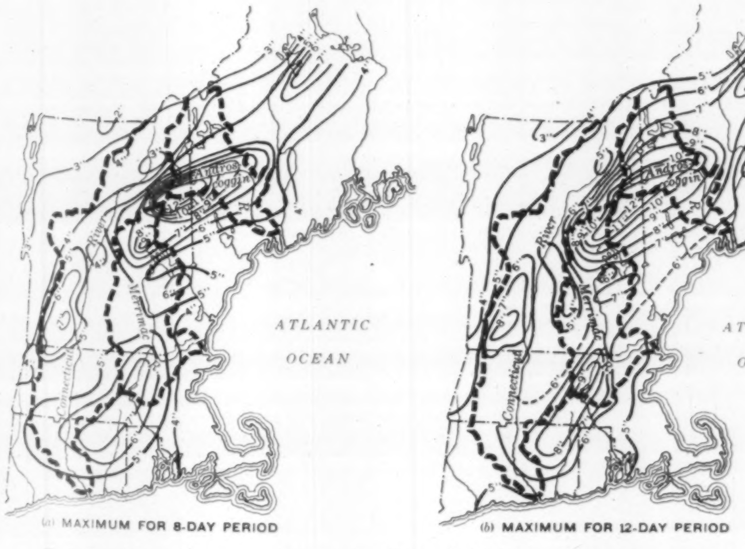
In March 1936, there were two major floods on most of the New England streams—one, with its peak from the thirteenth to the fifteenth, is sometimes referred to as the "ice flood," and the other, with its peak from the nineteenth to the twenty-first, has already become known as the "Great Flood." Conditions preceding the rainfall which was the immediate cause of the floods were favorable for unusually rapid and heavy runoff—the weather had been unseasonably cold until late in February without thaws; there was a thick snow blanket; and the ground surface was frozen. Beginning on March 9 the weather became warm and continued so throughout the rest of the month. At night the temperature seldom fell below freezing and during the day it generally was above 50 F. In some cases, temperatures of 60 or over were recorded.

EXCESSIVE RAINFALL A PRIMARY CAUSE

Beginning about March 9 and continuing through the twenty-first, heavy rain fell over most of New England, in two intense periods, the first on the twelfth and thirteenth and the second on the nineteenth to the twenty-first, with light rain on nearly every other day during this period. As this paper is being written, the U. S. Weather Bureau's climatological data are available from about one hundred stations or about half of those reporting to the Boston office.

From these records two maps have been prepared, Fig. 1(*a*) to show the maximum precipitation in an 8-day period, and Fig. 1(*b*) applying similarly to a 12-day period. Isohyetal lines have been drawn connecting points of equal rainfall, but these are subject to modification after records from additional stations become available. It is apparent that these were periods of extremely excessive rainfall, when it is considered that the normal precipitations for March in Maine, New Hampshire, Vermont, and Massachusetts, are 3.49, 3.19, 2.84, and 3.87 in., respectively. The Pinkham Notch record of 23.86 in. for March 1936 is said to be the highest ever registered in New England for such a period.

The region of greatest rainfall extended from the Connecticut River drainage basin across the watersheds



(*a*) MAXIMUM FOR 8-DAY PERIOD

(*b*) MAXIMUM FOR 12-DAY PERIOD

Fig. 1. New England Storm of March 1936, Based on Records from One Hundred Stations

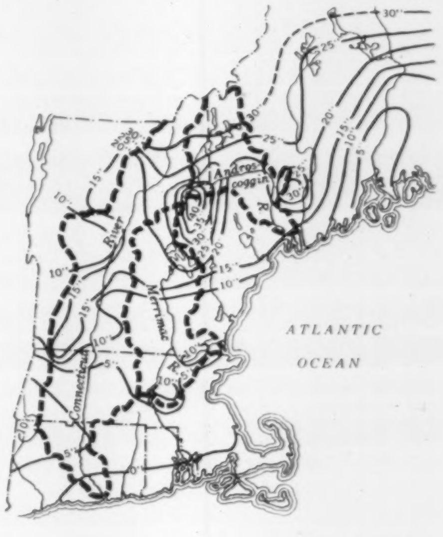


Fig. 2. Depth of Snow, March 9, 1936
Practically All Ran Off During Floods

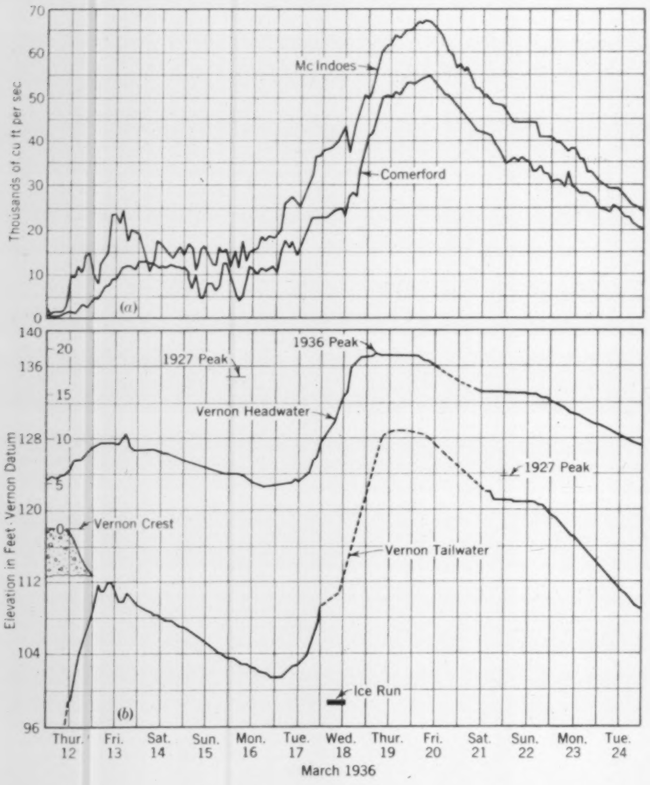


FIG. 3. HYDROGRAPHS OF 1936 CONNECTICUT RIVER FLOOD

(*a*) Flood Flow at Comerford and McIndoes, Vt.

(*b*) Flood Heights, Headwater, and Tailwater, at Vernon, Vt.

of the Merrimack, Saco, Presumpscot, and Androscoggin into the basin of the Kennebec, with a large area receiving as much as 12 in. of precipitation in 8 days, and a peak at Pinkham Notch, N.H., of 21$^1/_2$ in. in 12 days. Other areas of great but somewhat less intensity were central over southern Vermont, with a maximum of 8.95 in. at Newfane; eastern Connecticut and Massachusetts, with a large area receiving over 8 in. of precipitation and a maximum of 9.46 in. at Fitchburg, Mass.; and near Moosehead Lake, with over 8 in. at Greenville, Me.

From Fig. 1(*a*) and (*b*) the average precipitation over the Connecticut, Merrimack, and Androscoggin drainage areas has been estimated for the 8-day and 12-day periods as given in Table I. It should not be considered, however, that these areas include all those covered by the intense precipitation. Other adjacent basins not included in Table I received extremely heavy rainfall. It is known that there was an area of high precipitation east of the Androscoggin basin.

TABLE I. AVERAGE PRECIPITATION ON DRAINAGE BASINS IN 8- AND 12-DAY PERIODS

BASIN	AREA IN SQ MILES	PRECIPITATION IN INCHES	
		In 8 days	In 12 days
Connecticut	11,345	4.9	6.0
Merrimack	5,015	5.7	6.9
Androscoggin	3,470	6.6	9.7

As indicated in Fig. 1, the northeastern part of the Lake Champlain drainage basin including the Winooski, Lamoille, and Missisquoi basins in northern Vermont did not receive remarkably heavy precipitation. A few of the high precipitation records are given in Table II for periods of 1, 2, 4, 8, and 12 days. The highest precipitation throughout was recorded at Pinkham Notch, where records of 6.46, 10.32, 11.70, 18.79, and 21.51 in., respectively, were reached. At a number of stations, thunder and sometimes lightning was reported on March 13, 20, and 21.

TABLE II. SUMMARY OF A FEW RECORDS OF GREATEST PRECIPITATION

STATION	MAXIMUM PRECIPITATION				
	1 day	2 days	4 days	8 days	12 days
Pinkham Notch, N.H.	6.46	10.32	11.70	18.79	21.51
Rumford, Me.	5.07	5.46	5.84	9.42	11.70
Berlin, N.H.	2.20	2.72	4.90	6.44	9.83
Fitchburg, Mass.	3.69	4.18	5.51	7.64	9.46
Worcester, Mass.	4.98	5.44	6.32	7.95	9.05
Newfane, Vt.	3.45	4.15	4.60	7.47	8.95
Lincoln, N.H.	2.49	4.70	5.19	7.24	9.14

According to the early reports, the depth of snow on the ground March 9 was as shown in the map, Fig. 2.

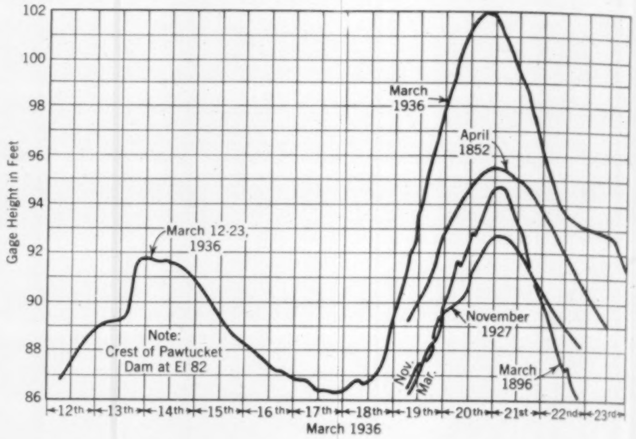


FIG. 4. MERRIMACK RIVER, 1936 FLOOD

Gage Heights at Pawtucket Dam, Lowell, Compared with Previous Floods

The lines of equal depth are tentative, subject to change when additional records become available. From this map it appears that a blanket of 15 in. or more in depth covered most of Maine, the northern two-thirds of New Hampshire, and the southeastern part of Vermont. Large areas in the White Mountain district were covered with from 2 to nearly 4 ft of snow. While the average snow cover over a large drainage basin cannot be estimated with great accuracy from so few records, computations have been made from this map which indicate average depths on the ground on March 9 over the entire

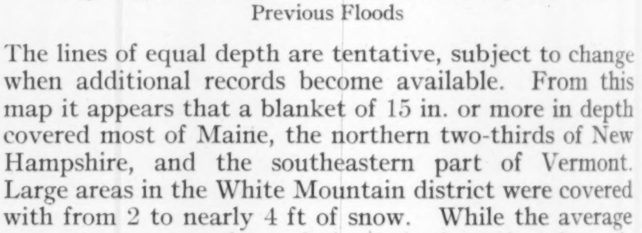


FIG. 5. HYDROGRAPH OF 1936 AND 1927 FLOODS AT HOLYOKE DAM, CONNECTICUT RIVER

Gage Heights by Holyoke Water Power Company

Androscoggin drainage area of 24 in., over the Merrimack of 12 in., and over the Connecticut of 13 in.

On March 23, following the floods, the available records show little snow left on the ground west of the Kennebec River drainage basin. On this date perhaps it is safe to say that, speaking of average conditions, there remained in the Merrimack basin only a trace, in the Connecticut about 1 in., and in the Androscoggin about 2 in. In any event almost all the snow melted during the flood.

Only a few data are available showing the water equivalent of snow. In the Androscoggin basin the best information indicates that perhaps the water content of the snow which melted during the 12-day period of precipitation was equal to more than 9 in. over the entire drainage area; on the Merrimack, to more than 4 in.; and on the Connecticut, to about 4 in.

If the precipitation in the 12-day period and the water equivalent of snow melting in the same period are added together, the results for the three basins give these astounding figures—over 19 in. for the Androscoggin, over 11 in. for the Merrimack, and over 10 in. for the Connecticut. All hydraulic engineers will recognize the extreme danger of such runoffs from frozen ground.

FLOOD FLOWS BREAK ALL RECORDS

Except on the rivers in the northwestern part of Vermont and the Connecticut above White River Junction, where the severest rainfall did not occur, the flood flows during this period generally exceeded greatly any previously reported. Such early records of the 1936 floods as are now available are given in Table III and compared with earlier floods. Hydrographs for three points on the Connecticut River in Vermont are given in Fig. 3. The discharge of the Connecticut River at White River Junction was less than 80 per cent of the 1927 discharge. Below White River Junction the flows were from 25 to 50 per cent greater than in 1927. On the lower Merrimack they were perhaps 75 per cent greater than in the 1852 flood and 75 to 100 per cent greater than in the 1896 flood (the 1927 flood on the Merrimack did not equal either of these). On the Swift and Ware rivers, present flows were about four times as great as those of 1927.

On the Connecticut River, the U. S. Geological Survey actually measured with a sounding weight and current meter a flow of 277,000 cu ft per sec, equivalent to over 97 per cent of the actual peak discharge of 285,000 cu ft per sec obtained from the gage height. On the Merrimack below the Concord River the Survey was able to measure from the cableway a discharge of 147,000 cu ft per sec, nearly 50 per cent greater than the previously known flood, although the peak of 174,000 cu ft per sec was missed, since it occurred during the night. Throughout the storm and flood the entire personnel of the Survey was engaged in making current-meter measurements. By being ready for this rare opportunity, the Survey has secured many discharge measurements at extremely high stages, which will result in development of rating curves for many stations, dependable in their upper reaches. The flows in the Merrimack at Lowell, and in the Connecticut below Turners Falls, reached points where the discharge can perhaps be visualized by comparison with the flow of Niagara Falls, which is frequently thought of as averaging a little over 200,000 cu ft per sec, including both American and Canadian falls.

To illustrate the speed with which the flood rose and the height it attained, a hydrograph for the Merrimack River is given in Fig. 4. The rate of rise was greater than in any other recorded flood, and the elevation reached was over 6 ft higher (above Pawtucket Dam at Lowell) than that in the 1852 flood. In addition, the water level

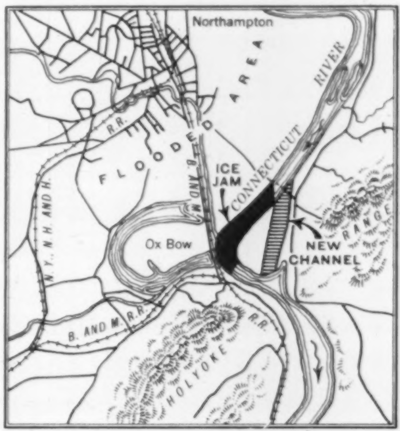


Fig. 8. River Straightened near Northampton, Mass. Obstructed by Ice Jam, It Makes Short Cut by New Channel

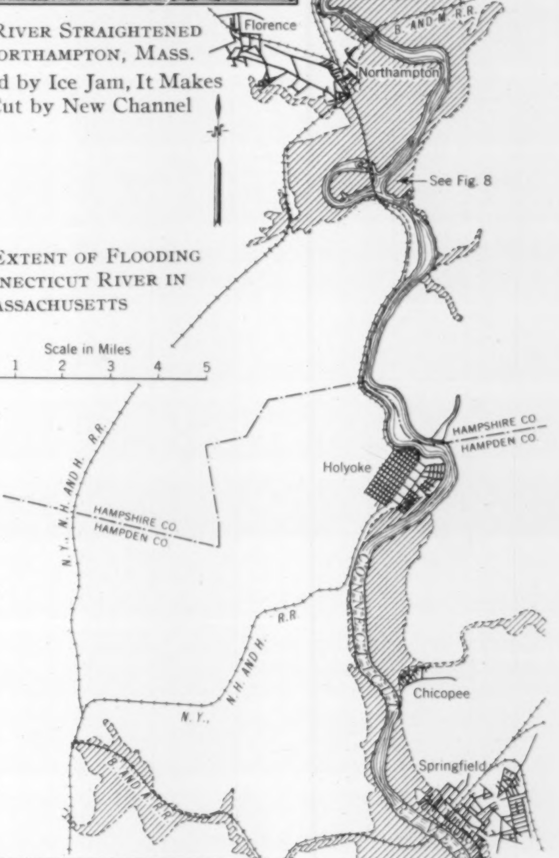


Fig. 6. Extent of Flooding by Connecticut River in Massachusetts

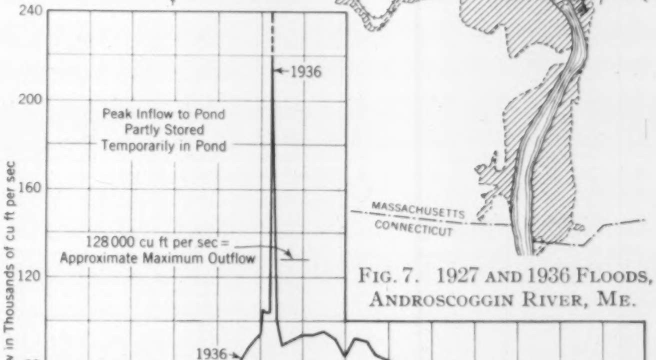


Fig. 7. 1927 and 1936 Floods, Androscoggin River, Me.

Ruins at Erving, Mass., on Millers River
Erving Mills Concrete Overflow Dam Destroyed and Road Beyond Washed Out

during this flood remained above the levels previously recorded for long periods. For example, at the Holyoke Dam on the Connecticut River, the water stage was above the 1927 peak for a total of over 63 hours (Fig. 5); on the Merrimack at Lowell, the corresponding period was about 57 hours; and on the Androscoggin at Gulf Island Pond, it was over 110 hours. Operators of many of the power reservoir systems realized that an unusual runoff was bound to occur and had drawn their reservoirs far down and operated them for storing great volumes of water, thus reducing the severity of the flood.

By overflowing their flood plains, the rivers increased tremendously their channel cross sections, as is illustrated for the Connecticut River through Massachusetts in Fig. 6. The velocity of the flood crest down the Connecticut, as reported by L. F. Conover, meteorologist of the Hartford office, U. S. Weather Bureau, was:

White River Junction to Holyoke	6 miles per hr
Holyoke to Springfield	4 miles per hr
Springfield to Hartford	0.7 miles per hr

On the Androscoggin an ice jam about 7 miles long between Livermore Falls and Lewiston extended from bank to bank and is said to have reached a height of about 30 ft above the water. When it started to move, it covered the distance of 18 miles to Gulf Island Pond in about $1^1/_2$ days. When it reached the pond (Fig. 7), the water level rose $2^1/_2$ to 3 ft in 10 minutes and the discharge is said to have increased tremendously. It is reported that the backwater required to remove the ice jams on the Androscoggin was about 10 to 20 ft.

On the Connecticut, an ice jam formed on the night of March 12-13 in a sharp bend in the river just below Northampton, shown in Fig. 8, practically damming the river and causing the flow to cut across the meadow around the jam. The backwater caused by this jam is said to have risen about as high as in the 1927 flood, causing substantial damage and great hardship in the low sections of Northampton. On this watershed, at least, the ice runs occurred with the earlier flood, and the receding waters left stranded on the flood plains huge masses of ice which later were picked up and carried out by the subsequent flood.

VARIOUS TYPES OF DAMAGE CAUSED

In Fig. 6 is shown an estimate of the area of the Connecticut River valley inundated at the height of the flood in Massachusetts. While the headwater at the Holyoke Dam was only about 2 ft above the corresponding elevation in the 1927 flood (Fig. 5), the tailwater was about 6 ft higher. Dikes at West Springfield,

Flood Relics at Haverhill, Mass.
Oil Stains on House Graphically Mark Peak of Flood and Silt Deposits on Lawns Witness Its Burden

Table III. New England Flood of March 19 and 20, 1936, Compared with Previous Floods

Data, Secured from Various Sources, Are Tentative Only and Subject to Correction. Some 1927 Data Have Been Revised Where New High-Flow Measurements Have Permitted Correction of Rating Curves

Location	Drainage Area	Previous Floods of Record				March 1936 Flood		
		Date	Stage	Discharge		Stage	Discharge	
				Cu Ft per Sec	Cu Ft per Sec per Sq Mile		Cu Ft per Sec	Cu Ft per Sec per Sq Mile
Connecticut River:								
Comerford, Vt.	1,650	(not built in 1927)				....	55,000	33.3
McIndoes, Vt.	2,200	(not built in 1927)				....	67,500	30.7
White River Junction, Vt. . . .	4,120	1927	35.0	131,000	31.8	30.7	107,000	30.0
Bellows Falls, Vt.	5,300	1927	?	......	....	24.7	150,000	28.3
Vernon, Vt.	6,220	1927	134.7	155,000	24.9	137.4	185,000	29.8
Turners Falls, Mass.	7,250	1927	....	171,000	23.6	....	205,000	28.3
Montague City, Mass.	7,950	1927	42.7	171,000	21.5	49.3	218,000	27.4
Holyoke, Mass.	8,120	1927	....	169,000	20.8	....	222,000	27.3
Thompsonville, Conn.	9,740	1927	12.3	199,000	20.4	16.7	285,000	29.3
Merrimack River Basin:								
Souhegan, Merrimac, N.H. . .	171	1924	11.8	9,300	....	16.2	17,000	99.4
Pemigewasset-Plymouth, N.H. .	622	1927	27.4	60,000	96.5	29.0	65,800	105.7
Merrimack, Franklin Junct., N.H.	1,510	1927	30.85	67,000	44 4	35.5	75,000	49.7
Merrimack below Concord River at Lowell, Mass.	4,424*	1852	60.6	104,000	23.5	68.3	174,000	39.3
		1927	56.5	75,800	17.1			
Merrimack, at Lawrence, Mass.	4,461*	1896	....	100,000	22.4	....	175,000	....
Androscoggin River:								
Inflow to Gulf Island Pond . .	1,810	1927	....	58,000	....	....	220,000 to 240,000	....
Outflow from Gulf Island Pond .	...	...	....	.....	....	....	128,000	....
Blackstone River:								
Woonsocket, R.I.	416	1927	14.0	12,900	31.0	14.4	13,450	32.3
Swift River, Mass.	184	1927	....	2,300	12.0	....	8,350	45.0
Ware River	97	1927	....	1,380	14.0	....	5,950	61.0

* Net area.

Springfield, and Hartford, which had been constructed above the highest water level previously known, were overtopped by several feet. Hartford was especially hard hit, as shown by the extent of the flood in Fig. 9.

Everywhere the damage to public property was tremendous, particularly to bridges, highways, sidewalks and curbs, and to a somewhat less extent to dikes and dams, and to water, sewage, and publicly owned gas and electric facilities. Unquestionably, the damage to private property—residences, farms, industries, railroads, and other public utilities—exceeds the loss to public property.

In much of the Connecticut and Merrimack valley, the thick deposit left on the land, often 1 to $1^1/_2$ ft thick, appears to be a sterile silt—soon drying and blowing about in the wind. Low bridges caused much damage by raising the backwater, and many were destroyed because the waterways were inadequate for such floods. Knowledge that conditions existed which would result in a heavy runoff caused protective measures to be taken and warnings to be given which saved much property and many lives.

Famous Water Filters in Difficulties
Lawrence, Mass., Filters Under Water—Motors in Station Saved by Disconnecting and Raising to Floor Above

One concrete dam which failed had a vertical upstream face. Since this dam "folded right over" when the ice struck it, the question is raised as to the wisdom of using a vertical-faced dam on such a stream.

At the start of the flood, reservoir operators kept in touch with each other, and with the principal meteorological stations at which information originates, by means of telephone. As the flood progressed, the telephone service failed. Some engineers then set up short-wave radio stations in their offices and in automobiles, and pressed into service amateur broadcasting stations upstream where available. If the stations at which meteorological information originates were provided with short-wave radio sending and receiving sets, and if they regularly used them, perhaps more dependable service might be given in such emergencies.

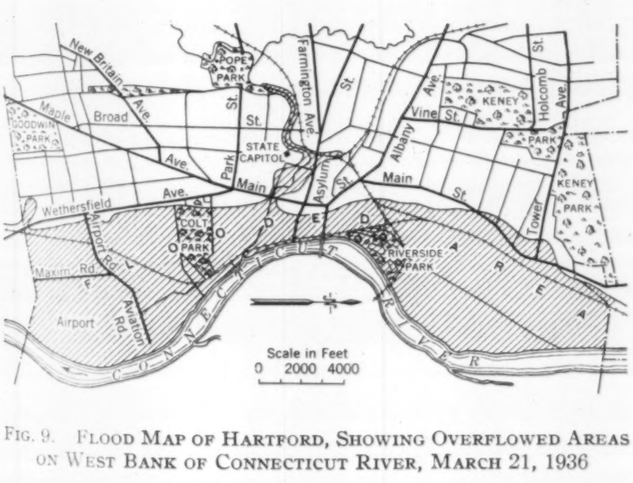
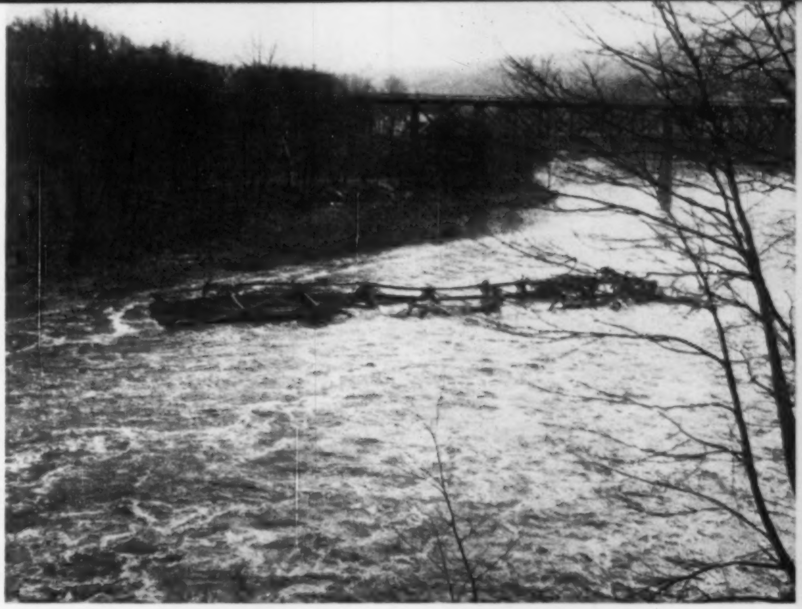


Fig. 9. Flood Map of Hartford, Showing Overflowed Areas on West Bank of Connecticut River, March 21, 1936



Some Bridges Stood and Some Fell—at Millers Falls, Mass.
Highway Bridge Washed Downstream and Railroad Structure Left Intact

In this flood the operating hydraulic engineers did heroic work to save their dams and canals, and in so doing saved the lives and property of thousands of people downstream. The municipal engineers, WPA engineering supervisors, and engineers of the various state departments did excellent work. The great reservoir of strong, willing labor in the CCC camps undoubtedly saved many structures and lives.

FURTHER STUDIES ARE ESSENTIAL

For the purpose of studying this catastrophe, the Engineering Societies of New England appointed a Committee on the 1936 Flood, consisting of K. R. Kennison and Carroll A. Farwell, Members Am. Soc. C.E., and Marcus K. Bryan, and the writer as chairman. Some of the conclusions of their report, dated March 26, are particularly pertinent:

"In many places structures have been so located or designed as to encroach on the flood channels of the rivers with the result that they have not only been damaged or destroyed themselves, but also have intensified the damage to other property. The permanent replacement of such structures should not be undertaken until careful engineering consideration has been given to each problem. In some cases, property too seriously encroaching on flood channels should be abandoned and the land developed as publicly owned open or park areas in order to prevent undue channel restriction."

"Complete and reliable data on the recent floods should be obtained promptly and all investigations and surveys should have sufficient engineering supervision of a high grade to insure their reliability and to properly coordinate all phases of the work."

Acknowledgment is gratefully given to the engineers of power companies, of cities, and of the federal government, and to the meteorologists, who have given their data freely for this paper.

The Mono Basin Project

Aqueduct to Supply Los Angeles with Additional Water Now Under Construction

By H. A. Van Norman

Member American Society of Civil Engineers

Chief Engineer and General Manager, Bureau of Water Works and Supply, Los Angeles, Calif.

To augment the flow of the Owens River Aqueduct, Los Angeles is preparing to divert to the Owens River watershed the major part of the stream flow of the Mono Basin. An 11-mile tunnel is the outstanding feature of the project, which also includes two storage reservoirs and several miles of reinforced concrete conduit. What was believed to be a new world's record for hard-rock tunnel driving was established on the project in April of 1935, and was broken thereafter three times in as many months. A maximum of 90 ft of progress was made at one heading in 24 hours on July 15. The project, costing about $11,000,000, is scheduled for completion in 1938.

ADDITIONAL water for the City of Los Angeles is the aim of the Mono Basin project. It embraces the acquisition of properties and water rights and the construction of conduits, tunnels, and reservoirs necessary for the collection and storage of water from the several streams in Mono Basin and its transmission to the Owens River and thence to Los Angeles. The project was made financially possible by a water bond issue, which was authorized by the voters of the city at an election held on May 20, 1930.

Three sources now contribute to the water supply of Los Angeles First in point of time is the Los Angeles River, the water of which has been owned by the city since pueblo days. Later, in the early years of the present century, several large pumping plants tapped the great subterranean reservoirs which are peculiar to the Los Angeles district, thus augmenting the Los Angeles River supply. Finally, in 1913, water from the snow-capped peaks of the Sierra Nevada in the north was brought by the Owens River Aqueduct 238 miles to Los Angeles.

Mono Basin (Fig. 1) is situated partly in Mono County, California, and partly in Mineral County, Nevada. It is about 47 miles in length and 22 miles in width and ranges in elevation above sea level from about 6,400 ft at the surface of Mono Lake to more than 13,000 ft on the highest peaks.

The principal water supply of the basin originates on the eastern slope of the Sierra Nevada The runoff from this area is collected by several streams which empty into Mono Lake, approximately in the center of the basin. In June of 1931, this lake had an area, exclusive of its two islands, of 86.8 sq miles. The surface drainage is supplemented by many springs, some of them of considerable size. Most of the springs are either in the bottom of the lake or near its shores; there are also a number along the base of the mountains that skirt the western shore. The easterly part of the basin is very arid, largely destitute of vegetation, and not productive of sufficient water to reach far into the basin.

The important streams of the basin, in decreasing order of magnitude of flow, are Rush Creek, Leevining Creek, Mill Creek, and Gibbs Canyon Creek. These four account for practically all the surface drainage of the basin, and are the ones from which a supplementary supply of water can be obtained.

Hydrographic studies have shown that it would be possible to impound within, and divert from Mono Basin a quantity of water which, added to the Owens River supply and supplemented by the Owens Valley underground supply when necessary, would enable the city to operate the Los Angeles Aqueduct continuously at its maximum mean and annual flow of 480 cu ft per sec.

For the 26-year period 1906 to 1931, inclusive, the average annual flow of all these Mono Basin streams, as nearly as can be determined, was 226 cu ft per sec, of which 195 cu ft per sec, or 86 per cent, could have been diverted had the water supply system now being

Finishing a Job the Glaciers Started

On the Grant Lake Moraine, an Earth Dam Is Being Built to Regulate the Diversion from Mono Basin

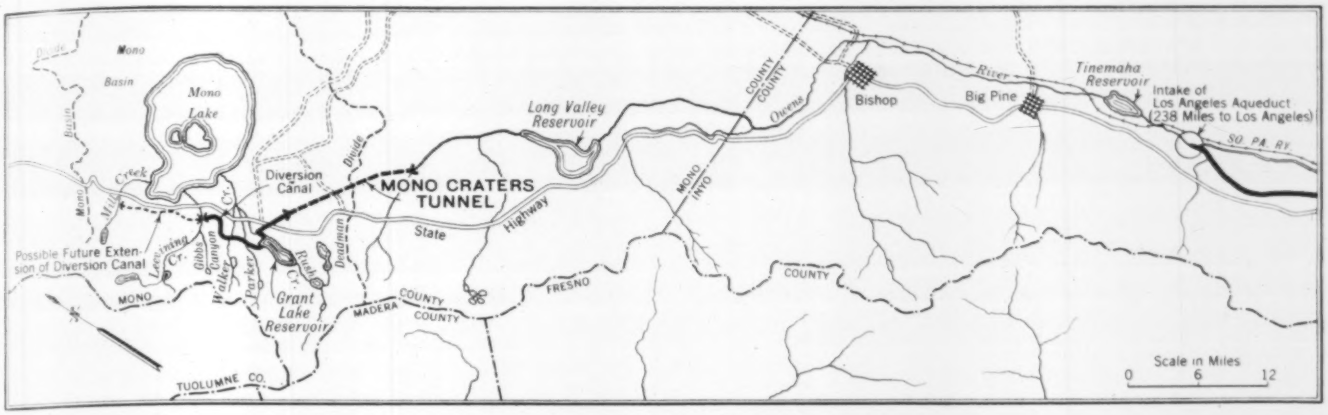
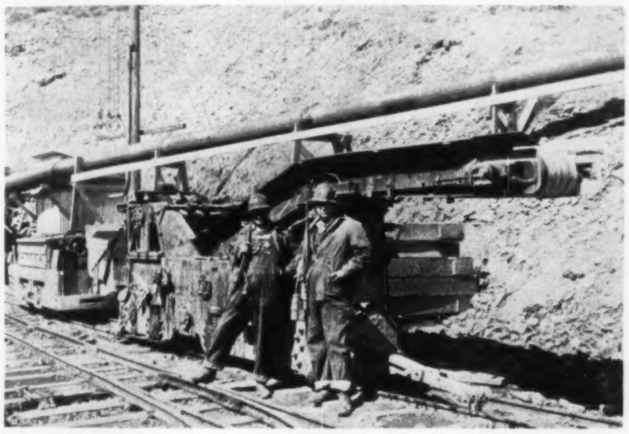


Fig. 1. Mono Basin Extension of Los Angeles Aqueduct

constructed been in operation. However, for the 11 years 1923 to 1933, inclusive, a period of subnormal stream flow, the average annual flow of these streams was only 150 cu ft per sec. Of this amount, 140 cu ft per sec, or 93 per cent, could have been diverted.

Prominent engineers have estimated that the water level of Mono Lake will eventually be lowered by the diversion until the lake occupies approximately one-third of its present area. The inflow from the springs around and under the lake will then balance the evaporation and hold the lake level constant.

The principal features of the project are (1) a diversion canal heading in Leevining Creek intercepting two tributaries of Rush Creek, and emptying into Grant Lake Reservoir; (2) the Grant Lake Reservoir, to store and regulate the flow of Rush Creek proper and the contribution of the diversion canal; (3) a gravity line (pipe line and tunnels) from the Grant Lake Reservoir outlet to the headwaters of the Owens River; and (4) the Long Valley Reservoir, several miles below the outlet of the tunnel, for storage and regulation of both Owens River and Mono Basin water. The diversion canal later may be extended northward from Leevining Creek to Mill Creek.



One of the Mucking Machines in Use in the Mono Craters Tunnel

This Equipment Has an Overall Width of Only 45 In.

The general plan of operation will be to divert the entire flow of the various streams, up to the capacity of the canal, throughout the entire year. Major fluctuations in discharge are to be smoothed out in the Grant Lake and Long Valley reservoirs.

The most suitable reservoir site in Mono Basin is Grant Lake on Rush Creek, where a capacity of 48,000 acre-ft will be created by a dam 72 ft in height above the stream bed. The dam, located in the narrows below Grant Lake, is now being constructed. It is of earth fill and rests on a morainal foundation. Preliminary work, to April 1, 1936, consisted of removing the top soil at the dam site and digging a ditch to divert the waters of Rush Creek during the period of construction. About 240,000 cu yd of earth had been removed from the dam site and 6,500 yd from the diversion ditch by this date.

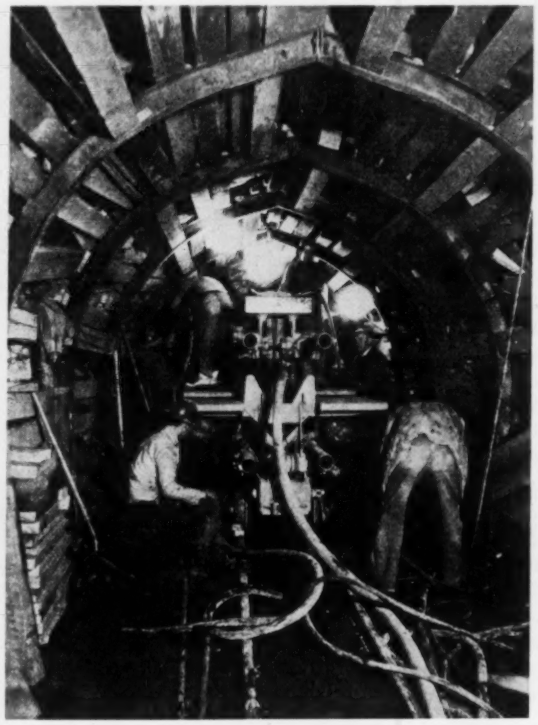
The different sections of the proposed Mono Basin Aqueduct will vary in capacity, to carry the added water as the different streams are diverted into it at convenient points along the line. From Leevining Creek to Walker Creek the capacity of the aqueduct will be 300 cu ft per sec, increasing to 325 cu ft per sec at the Walker Creek diversion and to 350 cu ft per sec at the Parker Creek diversion. The aqueduct from Grant Lake Reservoir to the Owens River is to be a gravity line, consisting of a short tunnel approximately 3,450 ft long at Grant Lake, about three miles of trapezoidal conduit, and the Mono Craters tunnel, 59,812 ft long, with a capacity of 420 cu ft per sec. The conduit sections are of the trapezoidal type, increasing in size from 6 ft $4^1/_2$ in. in height and width to 8 ft 3 in. as the capacity is increased. The walls have a batter of 1 in 12 and a flat-slab reinforced cover. The conduit will be buried, with a minimum of 2 ft of earth on top, to prevent freezing.

The Mono Craters tunnel, 11.3 miles in length, is to be 9 ft in diameter and to have a wide horseshoe-type section, concrete lined throughout. Because of its length, two shafts, one 950 ft deep and the other 350 ft, have been sunk along its axis to permit excavation to be carried on simultaneously from six headings. The estimated time required to complete the Mono Craters tunnel is $3^1/_2$ years. Actual drilling was started at the west portal in September 1934, and at the east portal two months later. Excavation for sinking the two shafts followed shortly thereafter. By April 1, 1936, 12,507 ft of tunnel had been drilled from the west portal, 9,095 ft from the east portal, and a total of 3,815 ft from the two headings reached by the shorter shaft. The deeper shaft had been put down 763 ft.

What is believed to be a new world's record for hard-rock tunnel driving was established at heading No. 1 on April 29, 1935, when 65 ft of tunnel was excavated in 24 hours. This was broken on May 17 and again on May 18, when an advance of 72 ft in 24 hours was made; also on July 15, 1935, 90 ft of progress was made in the same heading in 24 hours. For the three-month period—October, November, and December 1935—

tunneling progressed at the rate of 18.7 ft per day per heading in four headings.

It is planned to carry on construction continuously. The work is being conducted in three 8-hour shifts for six days a week. Four $3^1/_2$ - in. automatic-feed drifter drills mounted on a carriage built in the Water and Power Department shops are being used at each of the four faces. Compressed-air lines 6 in. in diameter have been installed, and ventilation is provided through an 18-in. 14-gage pipe. A specially designed mucking machine with an overall width of 45 in. is being used at each face. The machines are equipped with manganese cast booms and dippers. The muck is emptied into two-way side-dump cars, and is carried out in nine-car trains hauled by storage-battery locomotives. The track is 24-in. gage with 40-lb rail. California-type portable jump switches are used at the faces while ordinary one-way switches are used elsewhere.



JUMBO DRILL CARRIAGE IN OPERATION
Little Space Goes to Waste in the Mono Craters Tunnel Headings

In addition to the survey camp there are four permanent camps along the tunnel line, each housing about 200 men. All the camps are electrically lighted and all the kitchens are electrically equipped throughout. For heating, butane gas is used as fuel, the dormitories being equipped with hot-air units while the other buildings are heated directly by gas stoves. Every provision has been made for the comfort and welfare of the men. Roads have been built to provide access to all the camps; a water supply for camps and construction use has been provided, and a 33-kva power transmission line has been put through from the Southern Sierras Power Company's Leevining plant No. 3 to each camp, with a substation at each. Telephone lines have been built to provide direct communication by telephone and teletype from Los Angeles to the work. Because of snow and deep drifts during the winter months, snowsheds have been erected at each tunnel portal to provide access to the tunnel and permit the work to go on.

From the east portal of the Mono Craters Tunnel, the water will be emptied into the Owens River, whence it will flow approximately 30 miles into the Long Valley Reservoir. This reservoir will provide storage for 163,000 acre-ft of water and have a surface area of approximately 5,000 acres. The dam, of the rock-fill type, will be located at the upper end of the Owens River gorge. Its crest, 30 ft in width and approximately 530 ft long, will be 132 ft above stream bed. On the upstream side the dam will be faced with arc-welded steel on a slope of 1 vertical to $1^1/_2$ horizontal. The slope of the downstream face is to be 1 vertical to $1^3/_4$ horizontal. Including an estimated depth of 40 ft of stripping, the volume of the dam will be approximately 510,000 cu yd.

The estimated construction cost of the Mono Basin project, including Long Valley Reservoir, is $11,321,500, segregated as follows:

Mill Creek extension (for future construction).......	$ 371,500
Leevining to Grant Lake..........................	1,120,000
Grant Lake Reservoir.............................	540,000
Grant Lake to Mono Craters tunnel................	540,000
Mono Craters tunnel..............................	7,200,000
Long Valley Reservoir............................	1,550,000

It is estimated that an average of approximately 1,000 men will be employed over the 42-month construction period, with a maximum of some 1,800 men at any one time.

Work on the Mono Basin project is being carried on by H. L. Jacques, construction engineer, and E. A. Bayley, field engineer, under the direction of H. A. Van Norman, chief engineer and general manager of the Bureau of Water Works and Supply, City of Los Angeles, Calif. All three are Members of the Society.

LOOKING ALONG ROUTE OF MONO CRATERS TUNNEL

UPPER LEEVINING FALLS IN THE MONO BASIN

Stabilizing a Lake Michigan Bluff

Construction of Drainage Tunnel Relieves Hydrostatic Pressure and Stops Sliding

By Charles S. Whitney

Member American Society of Civil Engineers
Consulting Engineer, Milwaukee, Wis.

In 1927 it was discovered that a section of high bluff in a residential suburb of Milwaukee had separated itself from the adjacent soil and was sliding downward and outward into Lake Michigan at the rate of several inches a day. Among the houses overlooking the lake was one in an especially precarious position, being within a yard or two of the fissure formed by the movement of the 90-ft bluff. To protect this residence Mr. Whitney designed and constructed an unusual form of retaining wall, which depended for its support upon ties extending underground to concrete blocks in stable ground on the far side of the building. The means adopted proved effective. However, accelerated movement of the bluff, occurring in 1932, endangered other residences and stimulated an effort to check the movement itself. Drainage tunnels were then constructed in the unstable sand stratum underlying the properties, reducing the hydrostatic pressure and stopping the slide.

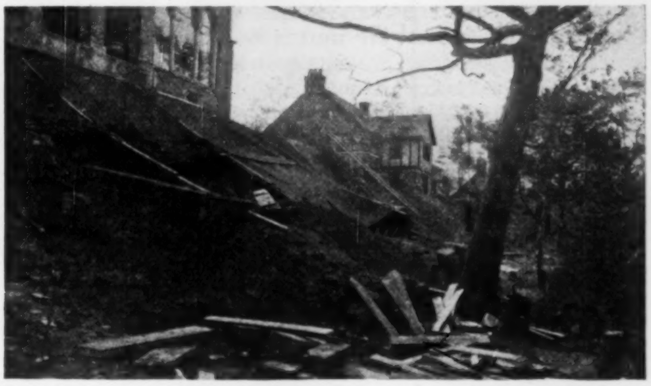
The high bluffs along the west shore of Lake Michigan are subject to serious erosion from waves, wind, frost, and both surface and underground water. These bluffs are composed of glacial tills, sands, and gravels. Where they have been especially unstable, bays have been formed, of which Milwaukee Bay and Whitefish Bay (the site of the work described) are examples.

In March 1927, a major movement of the bluff began in the section of Whitefish Bay between Henry Clay Street and Silver Spring Road. At that time the property between Lake Drive and the lake was divided into residential lots, about half of which were improved with expensive residences. The bluff was about 90 ft above lake level, with an average slope of about $2^{1}/_{2}$ or 3 to 1, and the greater part was heavily wooded. Concrete walls along the beach at the base of the bluff afforded it some protection for over half its length. No serious movement of that part of the bluff could be recalled by old residents.

One morning during the latter part of March 1927, a vertical crack was discovered in the lawn near the east walls of two residences about 20 ft back from the edge of the bluff. The property most seriously affected was about 380 ft deep from street to lake (Fig. 1), with the top of the bluff at that time about 160 ft from the street. The top land between the crack and the bluff appeared to be settling vertically, although there was actually a horizontal component not evident at the crack because of the stretching of the top soil and breaking back of the ground toward the crack. The movement progressed steadily at the rate of several inches daily. A few days after its discovery, the crack was about 300 ft long between the points where it disappeared over the edge of the bluff. As the settlement continued, the crack gradually extended further north and south until finally over a half mile of the bluff was involved. The movement was always greatest near the center of the slide, where the cracking was first discovered. During April, the settlement at the top of the bluff continued at an average rate of about 4 in. a day, with a maximum of about 6 in. By April 20, the top had settled a total of 12 ft. By the latter part of May the rate had decreased to about 1 in. a day. It was observed that the motion accelerated within 24 hours after a heavy rain, indicating that the tremendous mass was very delicately balanced. The mass was itself so deep and heavy that the weight of the rain probably did not affect it appreciably, and the acceleration is believed to have been due to the building up of hydrostatic pressure by the ground water.

Shortly after the appearance of the crack near the residences, a longitudinal extrusion of compressed clay formed about half way down the bluff, accompanied by longitudinal surface cracks and tipping of trees along the line (Fig. 2). The lower bank and the beach itself were moving eastward. Further examination showed that a similar action had in the past taken place toward the south, forming a shelf on the side of the bluff.

In March 1927, a Crack Was Discovered near the East Walls of Two Residences
The Houses Shown Are About 20 Ft from the Top of the Bluff



Progress of Slide About June 1, 1927
Jacking Operations Are Under Way in the Trench Back of the Wall, Under the Canvas

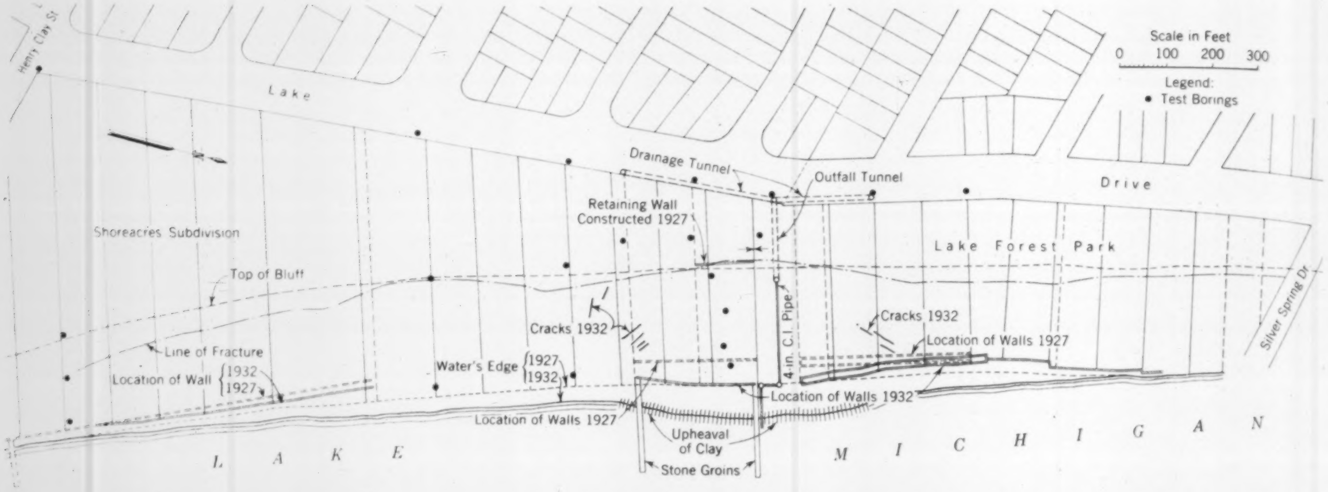


FIG. 1. PLAN OF A PART OF THE WHITEFISH BAY SECTION, SHOWING LOCATION OF DRAINS AND WALLS

A boring made at the edge of the bluff on March 26 showed a 27-ft bed of stratified water-bearing sand and clay covered with 24 ft of dense glacial till and underlain with a solid bed of stiff clay. Only the lower 5 ft of this water-bearing stratum was pervious enough to permit the free flow of water into the boring.

SUPPORTING AND PROTECTING A RESIDENCE

The residence nearest the slide was in a very precarious position. A 27-ft stratum of unstable material in the face of the cliff on the edge of which the house stood, was held in place only by back pressure of the sliding mass. The writer was retained to protect this house, a task that could not await completion of the general investigation. It was evident that a loss of sandy material below the house would cause tensile cracks in the surface stratum of clay, which might precipitate another slide and destroy the building. Diagonal borings indicated that no void was being left behind the slide into which the sand could escape, and as the fracture remained open for only a few feet below the surface, owing to the breaking back of the sliding mass, it was considered that no serious loss of material would occur as long as the top of the moving mass was well above the top of the sand stratum.

As the top of the slide approached the foundation level, it appeared desirable to exert lateral pressure against the clay supporting the foundations to prevent the development of tensile cracks in the surface stratum. The necessity for this was emphasized by the appearance of small cracks in the house walls, although there was no appreciable settlement. A trench was accordingly dug along the line of fracture and a line of jacks installed, which thrust against timbers on each side of the trench. These jacks were kept tightened by men on duty night and day until late in the summer, when it appeared advisable to build a permanent protection.

During the first three weeks in August, there was very little movement of the bank, which had dropped a total of about 18 ft up to that time. It was then decided that some permanent work should be undertaken to secure the house. Since there was no assurance that the slide had definitely stopped, no reliance could be placed for support on the ground east of the fracture. The east wall of the house stood within a few feet of the fracture, which, near the top, sloped down toward the lake with a batter of about one horizontal to four vertical. There was therefore no support for the ordinary type of retaining wall. As no settlement of the walls of the house had taken place, the substrata were evidently rigid and might remain so as long as sufficient back pressure existed. This was to be maintained by filling on top of the slide against the fracture.

There appeared to be no need of vertical underpinning for the house, and vertical supports would have been useless to resist the horizontal movement of the top clay stratum which would precede or accompany the formation of a new fault under the house. The shearing strength of the ground appeared sufficient if tension cracks could be prevented in the upper clay stratum. The weight of the house was negligible in comparison with the weight of the 24 ft of clay overlying the sand, and it was, in fact, considerably less than the weight of clay removed in excavating the basement. In order to afford horizontal support for the foundations and to prevent tension cracks in the clay, a novel type of retaining wall was designed and built during September. This consisted of a 10-in. concrete wall extending 12 ft below the original ground level at the house. No footing was used. To support the wall, a 40 by 21-in. horizontal concrete beam was formed on the west side about 4 ft from the bottom, being cut back into the solid clay. Six $2^1/_2$-in. round galvanized steel rods 56 ft long, spaced about 25 ft apart, were run back from this beam below the foundations of the house and anchored with steel plates in concrete blocks cast in pits in the hard clay west of the house. The rods were placed by boring holes through the clay and digging trenches through the basement floor where the rods passed under the house.

After the concrete had attained sufficient strength, a line of jacks was placed in the trench back of the wall and the top of the wall was forced out in order to develop tension in the steel anchor rods and pressure against the ground at the bottom of the wall. The space between the wall and the clay bank above the beam was then tamped full of sand. Measurements made since the wall was completed show no movement of wall or house, either horizontal or vertical. During the next five years it proved necessary, however, to place a large amount of earth fill outside the wall in order to keep the sand stratum sealed and the fill above the bottom of the wall as the slide proceeded.

GENERAL INVESTIGATION OF 1927 SLIDE

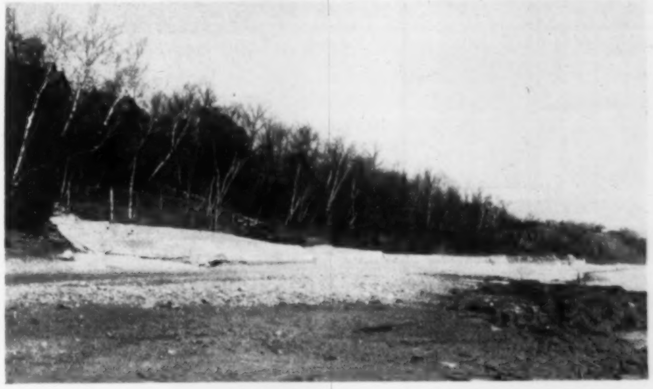
During April 1927, when it became evident that the slide was seriously endangering the greater part of the property between Henry Clay Street and Silver Spring Road, a number of the property owners joined in retaining D. W. Mead, now President of the Society, C. V.

Seastone, M. Am. Soc. C.E., and the writer to make a comprehensive investigation of the causes and to suggest remedies. A complete survey of the bluff and beach was made, with lines of stakes on the beach and on various bluff profiles, so that all movements could be measured. Numerous well borings, over 30 in all, were made on the different profiles and also to the west of the bluff. Topography and subsoil conditions were investigated as far west as the Milwaukee River, about a mile and a half back from the lake. As a result of the investigation, sufficient data were collected to indicate the unusual geological conditions which caused the slide.

Westward from the edge of the bluff, the surface of the land sloped gently to the bank of the Milwaukee River at about El. 40, Milwaukee datum. The land between the lake and the river, above lake level, consists of various deposits made by the different advances and recessions of the Lake Michigan Glacier. The deposits themselves vary considerably in texture within short distances, but in general consist of two sheets of dense till with a thick bed of stratified water-bearing sandy clay between. Near the lake, the top of the lower till sheet forms a solid clay table which slopes slightly down from the north, south, and west toward the point where the fracture first occurred (about El. 38). The form of the table, overlain with water-bearing sand, tended to concentrate the ground water at this point. The top till sheet, consisting of a dense, tough, impermeable, calcareous clay, is about 24 ft thick at the bluff and diminishes in thickness toward the west, disappearing about a quarter-mile back from the lake shore. This sheet is wider to the north and south of the slide, affording more protection to the sand stratum from surface water.

The water-bearing sand stratum varies materially in character, and varies in thickness from less than 10 ft to about 30 ft. Near the focal point of the slide, the upper part of the sand stratum consists of a few feet of sharp, clean, fine, pervious yellow sand. Below this is a stratum, about 20 ft thick, of sticky, clayey silt, somewhat coarser and more pervious near the bottom. The greater part of this material, although saturated with water, is so fine as to be almost impervious to flow. It is sufficiently cohesive, however, to be hard when dried, and will absorb enough water to become fluid when not kept under pressure. West of the point where the top clay stratum ends, the water-bearing stratum changes to a sharper sand, through which water flows with comparative freedom. Here the sand is exposed at the surface, and the ground water stood at times over 60 ft above lake level.

The ground-water level along the western edge of the top clay sheet must have been raised several feet by each heavy rain because the runoff from the east concentrated along that line. At the time the slide began, no storm sewers existed except in Lake Drive near the bluff, although many of the streets had been paved. During rains the gutters of the other streets discharged into open ditches in the sandy soil just west of the clay sheet. The hydrostatic pressure thus built up may have been transmitted through the sand to the lake bluff, contributing toward the accelerated sliding which took place after each heavy rain.



View of Beach Below Center of Slide, April 15, 1932
Showing Extrusion of Foliated Clay at Edge of Beach, in Right Foreground

It was further discovered from borings made along the beach that the formation directly below the point where the fracture first appeared is unusually weak. At this point the beach is underlain for a depth of about 20 ft with a wet sandy clay much softer than that to the north and south. Three geological factors therefore made the bluff particularly unstable at that location. These are the weakness of the support at the beach; the slope of the lower clay table and water-bearing stratum toward that point; and the narrowness of the impervious clay blanket, permitting concentration of underground water nearer the bluff at this point than elsewhere along it.

Borings through the center of the slide showed that the moving mass was much greater than was at first suspected. For a length of several hundred feet the entire bluff and beach were found to be in motion, the approximate zone of sliding extending about 20 ft below lake level, as shown in Fig. 2. The moving mass, consisting largely of stiff clay about 60 ft thick at the center, was sliding on a layer of wet sandy clay. There was no evidence of horizontal shearing below the beach, but rather of a plastic deformation of the soft sandy clay due to toe pressure from the bank. Surveys of the beach during April and May 1927 showed that at the worst section of the slide the beach was also moving eastward from 3 to 4 in. a day, about the same rate as the top of the slide.

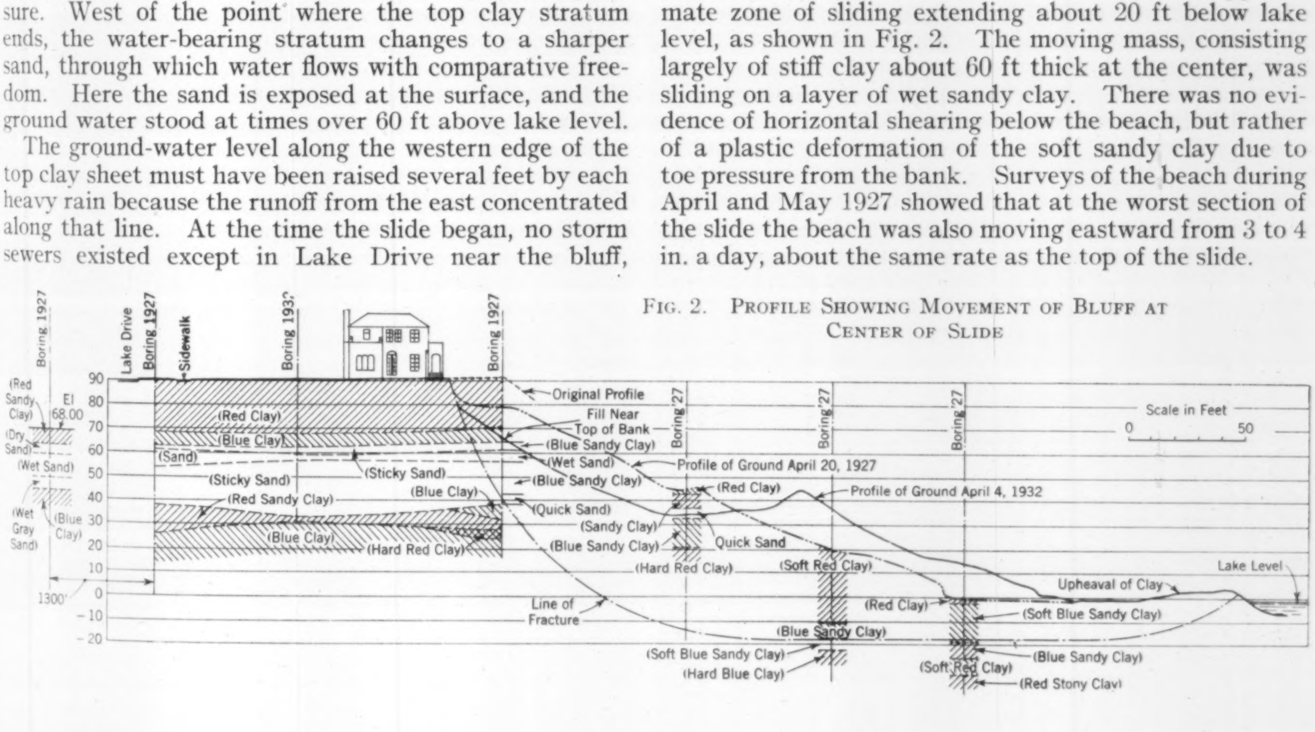


Fig. 2. Profile Showing Movement of Bluff at Center of Slide

Boring 1927
Lake Drive
Boring 1927
Sidewalk
Boring 1932
Boring 1927
Boring '27
Boring '27
Boring '27
(Red Sandy Clay)
El 68.00
(Dry Sand)
(Wet Sand)
(Wet Gray Sand)
(Blue Clay)
1300'
90
80
70
60
50
40
30
20
10
0
−10
−20
(Red Clay)
(Blue Clay)
(Sand)
(Sticky Sand)
(Sticky Sand)
(Red Sandy Clay)
(Blue Clay)
(Blue Clay)
(Hard Red Clay)
Original Profile
Fill Near Top of Bank
(Blue Sandy Clay)
(Wet Sand)
(Blue Sandy Clay)
(Quick Sand)
(Sandy Clay)
(Blue Sandy Clay)
(Hard Red Clay)
Line of Fracture
Profile of Ground April 20, 1927
(Red Clay)
Profile of Ground April 4, 1932
Quick Sand
(Soft Red Clay)
(Blue Sandy Clay)
(Soft Blue Sandy Clay)
(Hard Blue Clay)
(Red Clay)
(Soft Blue Sandy Clay)
(Blue Sandy Clay)
(Soft Red Clay)
(Red Stony Clay)
Scale in Feet
0
50
Lake Level
Upheaval of Clay

Since this movement was caused by hydrostatic pressure from the deep water-bearing stratum, local drainage from the face of the bluff could not be effective. It was also probable that unless the internal pressure were relieved, the slide would continue and additional fractures could be expected, which might destroy the residences. After a study of various possible methods of drainage, it was recommended that a deep drain be constructed paralleling the bluff approximately along the west edge of the top clay blanket in order to remove as much water as possible from the pervious sand leading to the bluff. It was proposed that this drain be built by the village and connected to a deep storm-sewer tunnel then being planned. Since the proposed drain would have been about 6,500 ft long and over 20 ft deep, the expense would have been considerable. Neither this drain nor the storm sewer were constructed. The sliding of the bluff continued at irregular intervals, and attempts were made by various owners to protect their individual properties by filling from the top and by drainage through pits or ditches in the face of the bluff.

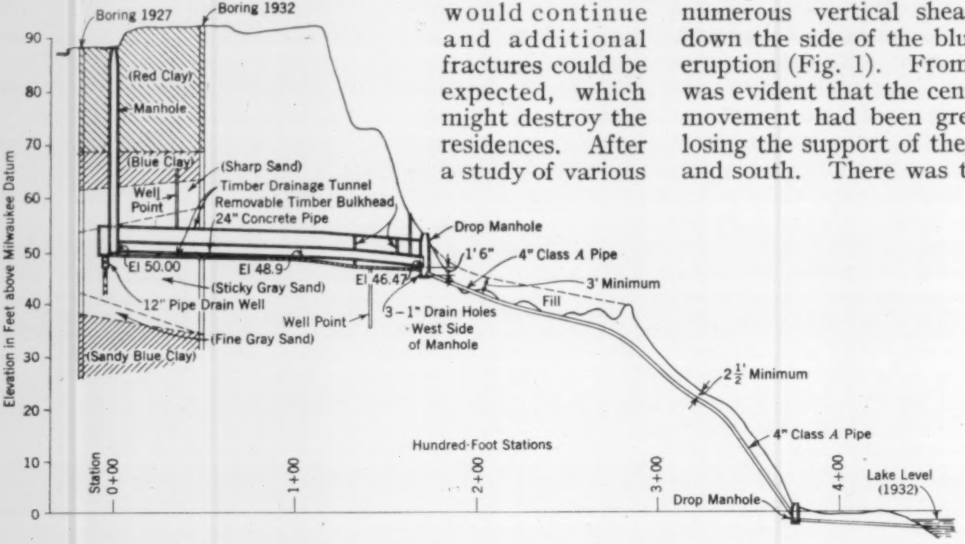


FIG. 3. PROFILE OF OUTFALL TUNNEL AND PIPE

INVESTIGATION AND DRAINAGE WORK IN 1932

In November 1931, after an unusual amount of rain following a two-year deficiency in rainfall, the movement of the bluff suddenly accelerated and continued at an alarming rate for about four months. In April 1932, the writer was again retained by the property owners most seriously affected, to make an investigation and suggest remedies. It was found that the fracture had progressed to the north beyond the Silver Spring Road, and now involved a strip of land about 3,000 ft long. The change in the profile of the bank at the center of this strip and the movement of the beach and retaining walls are shown in Figs. 1 and 2. The lower part of the bank had moved eastward about 50 ft, beach and all, permitting the upper mass to slip down behind it. The great amount of earth fill which had been placed from the top in an attempt to hold the undisturbed bluff had no doubt contributed to the movement, but was probably necessary to save the residences.

Investigation showed that the beach had been pushed eastward along a front of about 700 ft, forming a point projecting into the lake. Two new developments were particularly alarming. For the full length of this point, large masses of foliated clay were being extruded into the lake east of the beach and eroded by the waves. This condition, which is shown in one of the photographs, seemed to indicate that the shearing resistance of the clay below the beach had been overcome and that a fault plane had been established, thus providing a lubricated sliding surface under the entire mass. In addition, numerous vertical shear cracks extended diagonally down the side of the bluff west of the ends of the clay eruption (Fig. 1). From the position of these cracks it was evident that the central part of the slide, where the movement had been greatest, was breaking loose and losing the support of the more stable parts to the north and south. There was thus no reason to hope that the bluff was approaching a condition of equilibrium. It was considered imperative that remedies be applied as soon as possible. One hopeful element presented itself—during April, when the rainfall was light, the movement had slowed up and the groundwater level west of the bluff was lower than it had been in 1927.

On account of the tremendous mass of the moving material, its soft and unstable condition, and the softness of the ground below the beach, it would have been impossible to construct a barrier below the slide at a cost consistent with the value of the property. On the other hand, the records of other large slides and the fact that movement of the bluff had substantially stopped when the weather and the underground conditions were favorable, indicated that proper protection from ground water and lake erosion were the most practical remedies.

Since the ground water could not be removed effectively by drainage after it had reached the sliding mass, it would have to be intercepted before it reached the bluff. It had not proved possible to arrange for the construction of the drain recommended in 1927, so it was now decided to drive a tunnel into the face of the bluff, through the water-bearing stratum, beneath the east side of Lake Drive, there branching north and south across the front of the five properties most seriously threatened. The construction of such a tunnel involved a number of uncertainties, however. To protect all the properties fully would have necessitated the extension of the drainage tunnel for the full length of the slide, and if a short section only were constructed, as planned, there would be no way of determining in advance how much damage would be done by water coming around the ends. Moreover, it was not possible to plan just how the drain could be constructed to avoid the removal of material with the water, because of the extreme fineness of the material and its variability. Also, variations in the material made it impossible to determine definitely whether it would be necessary to use compressed air.

Additional test borings were made along the line of the proposed tunnel, and after some study of the materials to be encountered, the tunnel (Figs. 3 and 4) was successfully constructed without compressed air and within the estimated cost by General Contractors, Inc., working under a cost-plus-percentage contract. The outfall tunnel was started on the shelf half way up the bluff (El. 46) in the middle lot, where Lake Drive is nearest the bluff. There was no house on this lot and very little filling had been done, so not more than 30 ft of digging was required to reach solid ground. Fortunately, owing to dry weather the slide had practically stopped before the tunnel was started. A zone of very soft wet material was found at the fracture. No further movement was observed after the water-bearing sand was tapped.

The north and south ends of the outfall tunnel are at about El. 50. Although the bottom of the water-bearing stratum was at about El. 38, it was necessary to keep the tunnel well above that elevation as the funds available were very limited and it was necessary to do the cheapest job which might be expected to protect the five lots. Locating the tunnel at the bottom of the sand stratum would have lengthened the drift through the unstable material and would have necessitated the use of compressed air. Some uncertainty also existed as to whether the very fine bottom sand could be drained without dangerous removal of material. Furthermore, it seemed desirable to contact the upper stratum of sharp sand lying at about El. 55 in order to intercept any overflow of water above the sticky sand. For these reasons, the tunnel was driven within the sticky sand roughly in the middle of the water-bearing stratum. This did not entirely relieve the bottom of the sand of hydrostatic pressure, but since the tunnel was about 10 ft below the water level previously recorded in test holes, it was thought that this amount of drainage would serve to keep the bluff in equilibrium.

Outfall and drainage tunnels were 4 ft wide and 6 ft high, lined with 3-in. maple box sets stuffed with marsh hay to keep out the sand. Digging proceeded at the rate of about 10 to 20 ft a day. Water started to flow when the fracture was reached, and the rate of flow increased to a maximum of about 5,500 gal a day when the entire tunnel was completed. After two years, the flow dropped to about 2,400 gal a day. In order to relieve the hydrostatic pressure at the bottom of the sand, holes were cut in the tunnel floor (at about 20-ft intervals in the drainage tunnels) and sections of 12-in. sewer pipe were put down into the sticky sand. These holes were extended downward by means of augers until water flowed in from the pervious sand. They were then quickly filled with pea gravel to hold the sand down. This arrangement permitted the clear water to filter up freely at a velocity sufficiently low to prevent the sand from being washed out. It is believed that these drains are less liable to clog with fine material than if the flow had been downward. Similar drainage holes 24 in. in diameter were sunk in the drainage tunnels under the end manholes, which were constructed on spread concrete footings.

A 24-in. reinforced concrete pipe was laid with open joints in the bottom of the tunnel. The tunnel was then completely filled around the pipe with pea gravel. A 4-in. bolted cast-iron pipe was laid in a trench from the manhole at the bluff entrance to another on the beach. From the latter an 8-in. cast-iron pipe extended into the lake.

The total cost of the drainage system was about $12,750, including engineering. This amounts to $18.20 per lin ft of tunnel, or $24.00 per front foot of property. Following completion of the tunnel, the water standing in the test borings nearby dropped several feet. No movement of that part of the bluff has occurred during the three years since the tunnel was completed, except for a slight settlement of the uncompacted fill made on the various lots. No movement is visible in the tunnel where it crosses the fracture.

MEASURES TAKEN FOR PROTECTION OF BEACH

In order to prevent erosion of the soft beach materials by the waves, with consequent weakening of the bluff support, two stone block jetties of the porous type were built. These are necessarily experimental but similar jetties appear to have had the effect of building beach at some other points on the west shore of the lake. They were recommended since no other type of protection appeared practical because of the high cost and inability of a sufficient number of property owners to cooperate. Permanent protection from wave erosion will be provided at some future time if a proposed highway is constructed in what is now the lake along the shore line.

While the tunnel through the center of the water-bearing stratum has materially reduced the water pressure nearby, and may permanently stop the movement of the central mass of the slide, the situation to the north and south remains substantially unchanged. Where the sliding overburden is lighter, an almost complete removal of water from the sand stratum will be necessary to prevent excessive saturation. There it is not quite so much a question of water pressure as one of mere presence of water. For that reason it appears that before the entire slide can be controlled it will be necessary to extend the drainage tunnel along Lake Drive at a lower elevation to intercept the water in the lower sand. Staking, planting, and drainage from the surface of the bluff will help to prevent surface erosion, but the bluffs cannot be stabilized without the removal of ground water through deep drainage.

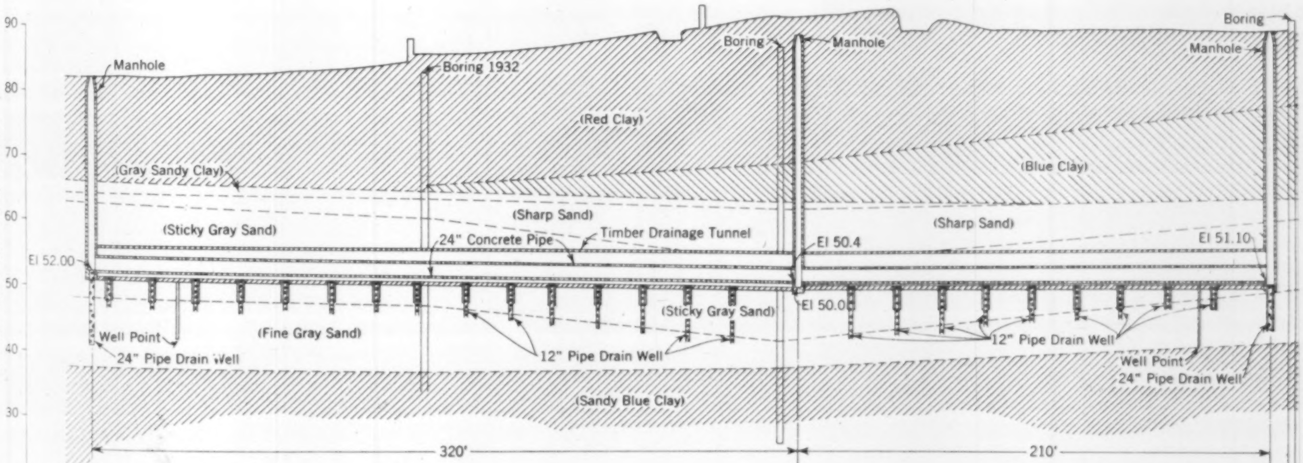


FIG. 4. PROFILE OF DRAINAGE TUNNEL ALONG LAKE DRIVE

Engineering on Public Works Projects

Presenting an Effective Procedure for Use on Self-Liquidating Projects

By Harry G. Hunter
Member American Society of Civil Engineers
Consulting Engineer, Greensboro, N.C.

EXPENDITURES for self-liquidating projects financed through revenue bonds are confined strictly to the funds allocated. When contracts are based upon unit prices, there may very well be insufficient reserve funds to meet an over-run in actual construction quantities. To meet this situation the lump-sum form of contract, without force account or extras, presents certain advantages over the unit-price type, although necessitating unusually complete plans and specifications. The detailed study required for the latter, however, eliminates the uncertainty about total cost and the proper distribution of overhead which often bedevils a unit-price contract, and therefore, in Mr. Hunter's opinion, is justified. Prequalification of bidders is also highly desirable. The article concludes with a brief account of the Pee Dee–Waccamaw bridges project, where the described procedure was used successfully.

A SELF-LIQUIDATING project is fundamentally one in which the revenues to be derived from operation will amortize the principal invested, pay interest charges on the outstanding indebtedness, and pay operating, maintenance, and other charges incidental to operation and ownership. These conditions determine the amount of principal which may be expended with reasonable certainty that the financing of the project will be sound. The amount of anticipated revenue which is used in setting up a project is at best an estimate based on such information as is available, and involves the forecasting of conditions likely to prevail over a period as long as thirty years after the project shall have been completed. The amount of revenue actually derived from operation will in any event be affected by conditions beyond the control of the owner, such as future competing facilities and the whims of the public. The principal to be invested is usually set at the maximum amount which the financing agency feels justified in advancing after considering the estimated revenue and allowing for unforseen contingencies during the period of amortization. The funds available for construction are therefore definitely established before the work is begun, and as these funds represent the maximum which the improvement can be expected to support, they cannot be increased without impairing the safety of the investment.

Obviously, the responsibility for keeping expenditures within the funds available falls principally upon the engineer handling the project. The direct costs of construction form the major part of the expenditures, and the amount available for construction can be approximated closely after deductions have been made for engineering fees, legal fees, interest during construction, administrative expenses, and related minor items which generally can be closely estimated.

The engineer is responsible for the preparation of plans and specifications, the selection of competent contractors, and the arrangement of construction contracts. His work should be conducted in such a way that the total costs come strictly within the funds available.

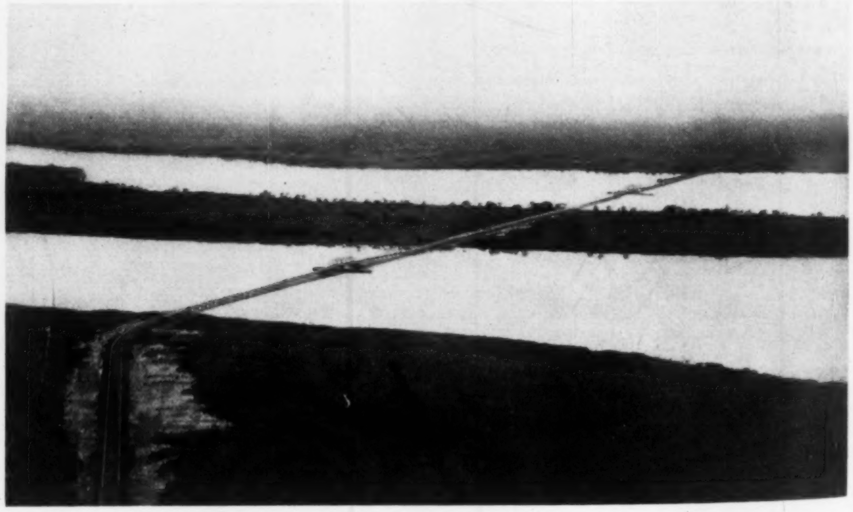
In connection with a project of the type here considered, the writer has devised a procedure which has proved satisfactory to the owner, the contractors, and the engineers, and has won the commendation of the PWA supervising engineers and auditors. This procedure will be described briefly for the benefit of others to whom it may be of interest.

PLANS SHOULD BE COMPLETE AND BIDDERS PREQUALIFIED

Before the plans were begun, complete field surveys and investigations of subsurface conditions were made. Based upon these data, plans and specifications were prepared, covering every detail of the project, and prospective bidders were informed of the precise nature, character, and amount of work to be performed. The specifications explicitly stated that no "unclassified" or "force account" work would be ordered or paid for and that the successful bidder must turn the structures over to the owner complete in every detail, in accordance with the plans and specifications.

Under this procedure the engineer must know to the last detail what he expects in the completed project, and must put his requirements into concrete form in the plans and specifications. He should explain himself definitely and unmistakably before asking any contractor to bid on the work, as he, better than anyone else, should know what the plans and specifications are intended to produce.

Prequalification of bidders has become a generally established practice in engineering construction. A standardized form of questionnaire for this purpose has been adopted by many state highway commissions,



General View of Pee Dee–Waccamaw Project, Looking Eastward from Georgetown, S.C.

but the smaller political subdivisions generally do not require prequalification. In the case here referred to, the simple but effective method used required that those desiring to qualify should file with the owner, not later than five days prior to the date the bids were to be opened, the papers described in the following paragraphs:

1. A financial statement, dated not more than five months prior to the date of filing, prepared in such manner and detail as to reveal clearly the real nature of assets and liabilities, preferably certified by independent auditors.
2. A statement of experience and performance record as principal contractor on work of similar character and magnitude, giving locations, dates, amounts of contracts, and names and addresses of owners and engineers.
3. A statement of equipment available for the work, its present location, capacities, condition, and the amount of work required to put it into service on the job.
4. A statement from a solvent bank or trust company, preferably a member of the Federal Reserve system, that it will supply such funds, other than those of the prospective bidder, as he may require to prosecute the work vigorously, uninterruptedly and faithfully to completion.
5. A certified check payable to the owner, in the amount stipulated, subject to deposit by him, and to be returned immediately upon decision by the owner that the depositor is not a qualified bidder, or, if qualified, to be returned to the bidder or retained by the owner in accordance with the terms of the proposal. The amounts required for the certified checks were expressed in dollars rather than in percentages of the amounts of the bids, so that prospective bidders could not draw inferences as to the amount of a competitor's bid.

In practice, there is considerable difference between refusing qualification to an incompetent bidder and in rejecting his low bid because he is not qualified. The latter procedure may easily lead to litigation, and as the burden of proof rests on the owner, delays and expense inevitably ensue. But there is small chance of serious misunderstanding when the prequalification procedure is further safeguarded, as was done in this case, by the statement that "prospective bidders, in availing themselves of the privileges of this procedure, do so of their own free will and volition and with the understanding that the decision of the owner in the matters herein referred to is final and results from the exercise by the owner of discretionary powers reposing in said owner." It sometimes happens that a prospective bidder is not qualified for a general contract, but is fully able to perform a subcontract. If he is informed two or three days prior to the letting that he cannot bid upon a main contract, he still has ample time to prepare a bid for a subcontract and to file it with those qualified as general contractors. Other bidders may be competent to handle a general contract but may desire to sublet a part of the work which the disqualified contractor is qualified to perform.

The certified check filed as a part of the prequalification procedure serves as a proposal guarantee in the usual manner. The condition that this check be subject to deposit prevents its posting by a person who may have made special arrangements with the bank concerned by which credit is extended beyond the limit of the bidder's account when it is known that the check will not be presented for payment.

Bids are filed on forms of the conventional type, bidders naming their prices and the calendar time in which they propose to complete the project. Each bid must be accompanied by a letter from an acceptable surety company stating that, if the bidder is awarded a contract, it will execute the required bond.

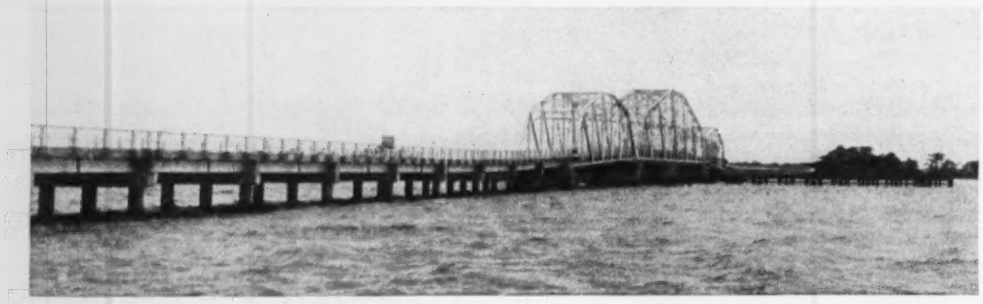
View of the Pee Dee River Bridge
The Western Causeway Appears in the Foreground

In projects of the self-liquidating type, interest during the construction period is directly related to the time required to complete the work. Calendar time is preferable to working time because in the latter case good or bad weather makes the advance determination of the construction period very uncertain. Calendar time, on the other hand, sets up a definite date by which the project must be completed or liquidated damages will begin. Obviously a proper comparison of bids entails a consideration of costs incurred or savings procured by longer or shorter construction periods.

LUMP-SUM FORM OF CONTRACT PRESENTS ADVANTAGES

In the procedure adopted, contracts were all arranged on a lump-sum basis, each contractor agreeing to construct, complete, and deliver to the owner a "turn-key" job for a fixed price. This may have brought about a contract price slightly higher than the total bid, under a unit-price form; nevertheless it furnished the owner with definite information as to the complete cost of the project prior to the award of contracts, and assured him that the total expenditures would not exceed the available funds. The position of the owner was further safeguarded by the requirement that the contractor furnish a fulfillment bond. This is, in effect, a completion bond with the added provision that the release of surety and principal may occur only upon completion of the contract or default in payments due the contractor from the owner. As a further safeguard to both contractor and owner, the contractor was required to provide broad-coverage builders' risk insurance, running jointly to the contractor and the owner as their respective interests appeared.

The lump-sum form of contract in engineering construction work offers advantages to both owner and contractor apart from the determination of total cost in advance of construction. Unit-price contracts work a hardship on the owner when actual quantities exceed estimated quantities because unit prices carry allowances for equipment charges, overhead expense, and other fixed costs which are not increased by an increase in quantities. Conversely, unit-price contracts work a hardship on the contractor when actual quantities are less than estimated quantities, for he then loses the proportional part of his fixed expenses which is borne by the quantities eliminated. As a matter of fact, the loss of a small percentage of quantities for a single item may largely wipe out the greater part of the profit anticipated by the contractor.



VIEW OF THE WACCAMAW RIVER BRIDGE, CENTRAL SECTION
The 300-Ft Swing Span Is Flanked by Two 148-Ft Fixed Spans

The engineer, of course, must assume greater responsibility in arranging contracts upon a lump-sum basis. He must provide complete and accurate information to prospective bidders concerning conditions at the site of the work; he must be explicit in the statement of requirements to be fulfilled by the completed construction; he must make up his mind in advance of the award of a contract concerning every vital question affecting the contractor's operations; and he must express his conclusions clearly at the proper place. Unfortunately this procedure is somewhat at variance with the practice of many engineers, who apparently reserve the right to change their minds during the construction period and often require contractors to perform, at the owner's expense and by means of extra work or force-account orders, items of work overlooked or not contemplated in the original plans and specifications.

There may be some criticism of the writer's position on the ground that the owner is often unwilling to bear the expense of procuring full and adequate information with respect to a proposed improvement during the preliminary stages of its development. Under these conditions, the engineer would be delinquent in his duty if he did not impress upon the owner the benefits to be derived from furnishing prospective bidders with complete information, and remind the owner that such information, once collected, is available for use at any future time if the project should be temporarily abandoned or delayed. At the same time, the engineer owes it to himself to have at his disposal full and complete data on any project with which he is officially and responsibly associated.

BRIDGE CONSTRUCTION PROJECT AT GEORGETOWN

The procedure described was successfully employed in the construction of two bridges over the Pee Dee and Waccamaw rivers, with adjacent causeways, at Georgetown, S.C. A loan and grant of $760,000 was allocated by PWA to Georgetown County for this work, and the entire program was carried out in conformity with its rules.

The structure across the Pee Dee River consists of one 212-ft electrically operated swing span and forty-four 37-ft 6 in. steel beam spans with concrete decks carried by reinforced concrete pile bents. The structure across the Waccamaw River consists of one 300-ft electrically operated swing span, two 148-ft fixed truss spans, and seventy-two 37-ft 6-in. steel-beam spans carried by reinforced-concrete pile bents. Six mass piers carried by timber piles and two rest piers carried by groups of reinforced concrete piles were provided.

The westernmost embankment is 2,400 ft long and that between the bridges is 1,550 ft long. The lower part of the embankments, to within $1^1/_2$ ft of grade, is of sand dredged from the Pee Dee River, while the upper part, including a blanket over the slopes, is composed of material hauled in from high ground. A mixed-in-place asphalt pavement and wooden guard rails were provided on the embankments.

Two contracts were arranged for the main part of the project—one for the trestles and the substructure, including fenders, and the other for the superstructure of the truss spans and the causeways. In addition, there was a contract for a five-room residence for the bridge foreman, and another for a toll-collection system. All contracts required the contractors to coordinate their operations by direct negotiation between themselves, and specifically placed the responsibility for delays that might arise out of interferences. The fullest cooperation of the contractors resulted from this arrangement, which placed the responsibility for progress and completion directly upon the parties who controlled those features of the work, and eliminated any possibility of the owner's becoming involved.

As a safeguard for the contractor's interests, all contracts executed before applicable funds were in the hands of the owner provided that the contracts should become in no respect binding and operative until the owner notified the contractor, in writing, that the funds with which payments were to be made were on hand and available for the purpose.

So far as known, the procedure outlined and described here has not heretofore been applied elsewhere. The results obtained were gratifying to all interested parties. The owner was never in doubt as to the ultimate cost of the project; each contractor knew precisely what he was required to do and what he would receive for doing it; the engineers were not continually bothered with requests for extras or with petty disputes between contractors with respect to precedence; and the representatives of PWA found that the procedure operated to expedite the auditing of accounts and the administration of the bond purchase agreement between the government and the owner. Finally, the project was completed well ahead of the time specified, and the owner was able to accommodate the public and derive revenue in advance of the anticipated date.

CLOSE-UP OF THE WACCAMAW BRIDGE WITH SWING SPAN OPEN
The Trestle Deck Is of Concrete Carried by Steel Beams on Concrete Pile Supports

Building Roads Through Unstable Formations

Use of Explosives Hastens and Controls Settlement of Permanent Fill in Marshy Ground

By J. M. JEFFRIES

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MODERN high-speed traffic, in creating a demand for straight and level hard-surfaced highways, has been a major factor in the abandonment of the old "floating-fill" roads, as well as the crooked, hilly detours which formerly were the only alternative. Today highway engineers boldly extend alignments directly across swampy areas, dumping fill in quantity into the marsh. Mr. Jeffries' paper is concerned with the various methods for sinking this fill to solid bottom by the use of explosives and controlling its settlement by the same means. The so-called "wedge" method is particularly interesting. By firing charges at the margins of the road a fraction of a second previous to the customary underfill blasts, a way of escape is provided for the unstable material lying under the sides of the V-shaped fill, allowing the latter to settle vertically to the bottom of the swamp.

IN swampy country, motorists on relocated highways sometimes see abandoned roads supported on logs which float in the unstable, water-saturated soil. Few can visualize such narrow, wet, and seemingly impassable surfaces as roads, and this in itself constitutes evidence of the progress that has made possible the construction of permanent roads through unstable formations.

Engineers and road builders of past generations detoured whenever practicable around areas containing soil too soft to serve as a road base. In those cases where it was necessary to build a road across a swamp, the fill was usually placed on a mat of logs, and was known as a "floating fill" because the log mats were separated from solid bottom by semi-liquid mixtures of peat and mud. This type of road required the constant addition of fill material, and differential settlement of adjacent sections made it impossible to place any permanent surface.

While the replacement of the horse by the automobile created a demand for better road surfaces, the high-speed traffic of late years made necessary the elimination of curves, the lowering of grades, and the widening of highways. Straight, level roads in many cases became possible only if they could be built directly through swamps. Highway engineers thus had to find a method of settling fill material through unstable formations to solid bottom.

In 1926 the Minnesota Highway Commission used explosives to settle fills to solid bottom through peat swamps, and similar work was completed in Michigan at about the same time. It is thought that this was the first fill-settlement work ever done. Since then similar projects have been carried out in California, Delaware, Florida, Maine, Maryland, New Jersey, New York, Rhode Island, Washington, Wisconsin, and other states. As a result of the experience gained from these experiments it is now known that fill settlement is a practical and economical operation. Cost records indicate that it is more expensive to refill and resurface every year than to settle the original fill properly, once and for all.

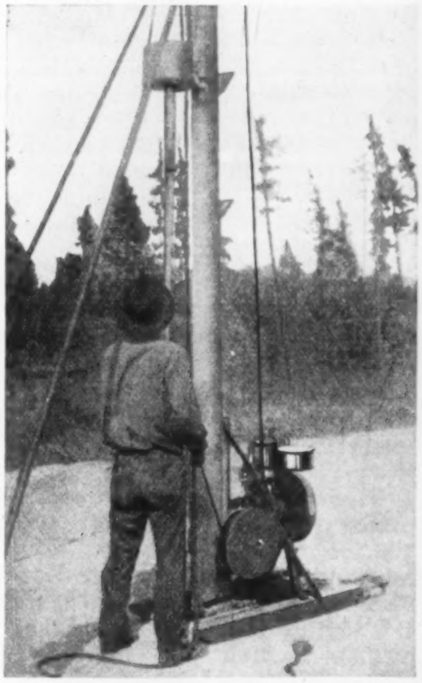


FIG. 1. POWER-DRIVEN SOUNDING MACHINE DEVELOPED BY THE MINNESOTA STATE HIGHWAY DEPARTMENT

The Small Gasoline Engine Furnishes Power for Driving Pipe

This process has passed through an evolutionary period, and both good and bad results have been obtained. The methods in general use, together with the interesting and informative features of certain jobs, will be discussed in an effort to point out some of the more important points in planning fill settlement work.

THOROUGH PRELIMINARY STUDY OF SITE IS NECESSARY

In the consideration of any project, the first step should be a rough determination of the depth of the swamp and the contour of the solid bottom. This may be done rapidly and economically in soft swamps with bamboo poles similar to those used for fishing rods. If the ends of the poles are telescoped and wired together, investigations of swamp materials may be made to depths of 50 ft or more.

After preliminary investigation has indicated the most desirable location for the fill, a mechanical sounding machine should be used to explore the unstable material at 25-ft intervals down the center line of the proposed fill, taking cross-sections at least every 100 ft. The center-line profile and the cross-sections should then be plotted for a permanent record.

It is important that the cross-sections be taken well beyond the point where the toe of the fill is expected to come to rest, as it is sometimes found that a shift in alignment will effect large savings in the amount of fill placed, as well as in the cost of settling it. As an illustration of what may happen, I might mention a recent project in which soundings were taken along the center line only. The resulting profile indicated that unstable materials would have to be displaced to a depth of 20 ft. Without further investigation filling was commenced, and material was dumped in at one location for a month without advancing. Subsequent investigation showed that the solid bottom sloped sharply downward to the left of the center line. Had cross-sections been taken in the first place instead of mere center-line soundings, the center line could have been shifted to the right and the cost of settling the fill greatly reduced.

An illustration of a power-driven sounding machine appears in Fig. 1. This machine has its driving unit mounted on a mast which is attached to skid runners. These runners also carry the power plant, which consists of a one-cylinder gasoline engine rotating the "nigger-head" drum. A rope looped around the drum runs up over a pulley at the top of the mast, and is then fastened to the heavy driving unit. When the tail rope (grasped by the man in the picture) is pulled in short jerks, the weight slides up and down against the reducer joints on the ends of a 2-in. pipe passing through a hole in the center of the weight. In this manner sounding rods or pipes for loading explosives may be driven and withdrawn. A special point used in making soundings will take samples of the unstable material at any depth. Modifications of this sounding machine have been made by various states to adapt it to special conditions. For example, a special sampling point and pipe connector developed by the Delaware Highway Department for use with a small sounding pipe can be connected and disconnected in a fraction of the time required when a standard pipe coupling is used.

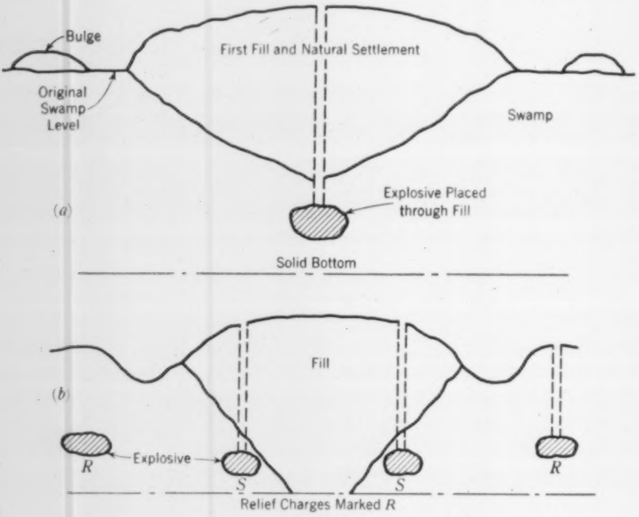


Fig. 2. The Wedge Method of Settling Fill Through Unstable Material

(*a*) After the Mat of Vegetation Has Been Broken, the Fill Is Piled High Along the Center Line and Allowed to Settle. After the Charge Is Fired the Fill Drops to Solid Bottom

(*b*) Following the Procedure Outlined in (*a*), More Fill Is Added. The Relief Charges, *R*, Are Fired a Fraction of a Second Before the Side Charges, *S*, Providing an Outlet for the Unstable Material

MAT BLAST SHOULD PRECEDE DUMPING FILL

After complete soundings have been taken and the profile of solid bottom is established, it is advisable to make a mat or ditch blast down the center line of the proposed fill. This breaks the mat of grass and roots that usually covers swamp material, and later gives direction to the fill settlement. Some highway engineers believe it is desirable to blast the mat the full width of the proposed fill, but all agree that a propagated blast down the center line is good practice. Following the mat blast, the fill material should be placed along the center line in as narrow a width as possible and built up as high above grade as is commensurate with the depth of the unstable material and the equipment available. After all natural settlement has taken place, the fill will be similar, in most cases, to that shown in Fig. 2 (*a*). An explosive charge is then placed as shown in that figure, and fired. The center of the fill is thereby dropped to solid bottom. More fill material is then added, and side or underfill charges *S* are placed as shown in Fig. 2 (*b*). The firing of these charges in the early state of the art marked the end of this part of the work.

But experience showed that while the fill was settling and displacing the unstable material below, bulges appeared in the swamp level on each side of and parallel to the edges of the fill. It was soon realized that if the displaced unstable material was provided with an avenue of escape, the resistance to fill settlement would be decreased. At first ditches were blasted outside of and parallel to the edges of the fill. This helped matters, but since most of the unstable material is usually in a semi-liquid condition, the relief ditches were sometimes partially refilled by the pressure of the fill before the underfill blasts were detonated. Later, explosive charges were placed in the relief holes *R*, shown in Fig. 2 (*b*), and detonated simultaneously with the underfill charges by means of electric blasting caps. Improvement was noted, but it became apparent that some of the force resulting from the explosion of the relief charges was acting in opposition to that exerted by the underfill charge, hindering the movement of the unstable material out from under the fill. It was obviously necessary to develop a method of detonation such that the relief charges would be fired a sufficient interval in advance of the underfill charges to prevent a conflict of forces and yet not allow time for the opening created by the relief charges to refill.

To meet the necessity of split-second firing control of blasting caps, a special type of blasting machine was developed. This machine has three binding posts to which two complete circuits may be so attached that one circuit will fire a controlled fraction of a second before the other circuit. This method of firing fill-settlement blasts has been widely used and has proved both advantageous and practical. The material being thrown high in the air in Fig. 6 (*b*) is from relief charges fired a fraction of a second before the underfill charges.

The method just described, of settling the center of the fill to solid bottom first and finishing the settlement with side and relief charges, sometimes called the wedge method, is thought to have been developed and used first by the Minnesota Highway Department. A different method is used by some who have thought it impractical to make a narrow fill and then widen it, and it is not uncommon today to make a full-width fill and then blast the unstable material from beneath it, using three rows of bore holes. One row is placed on the center line, and the other two rows about 15 ft on each side. In some

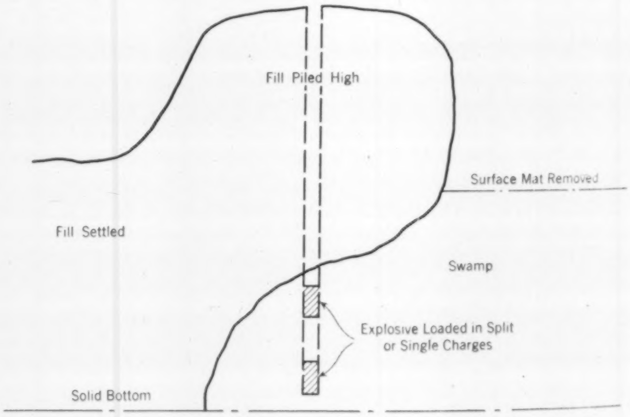


Fig. 3. The Toe-Dump Method of Settling Fill Is Effective in Shallow Swamps

After the Mat Is Broken, the Fill Is Heaped Up at the Entrance to the Swamp; Holes Are Punched and Loaded; and the Unstable Material Is Blasted Out in Front as the Work Proceeds

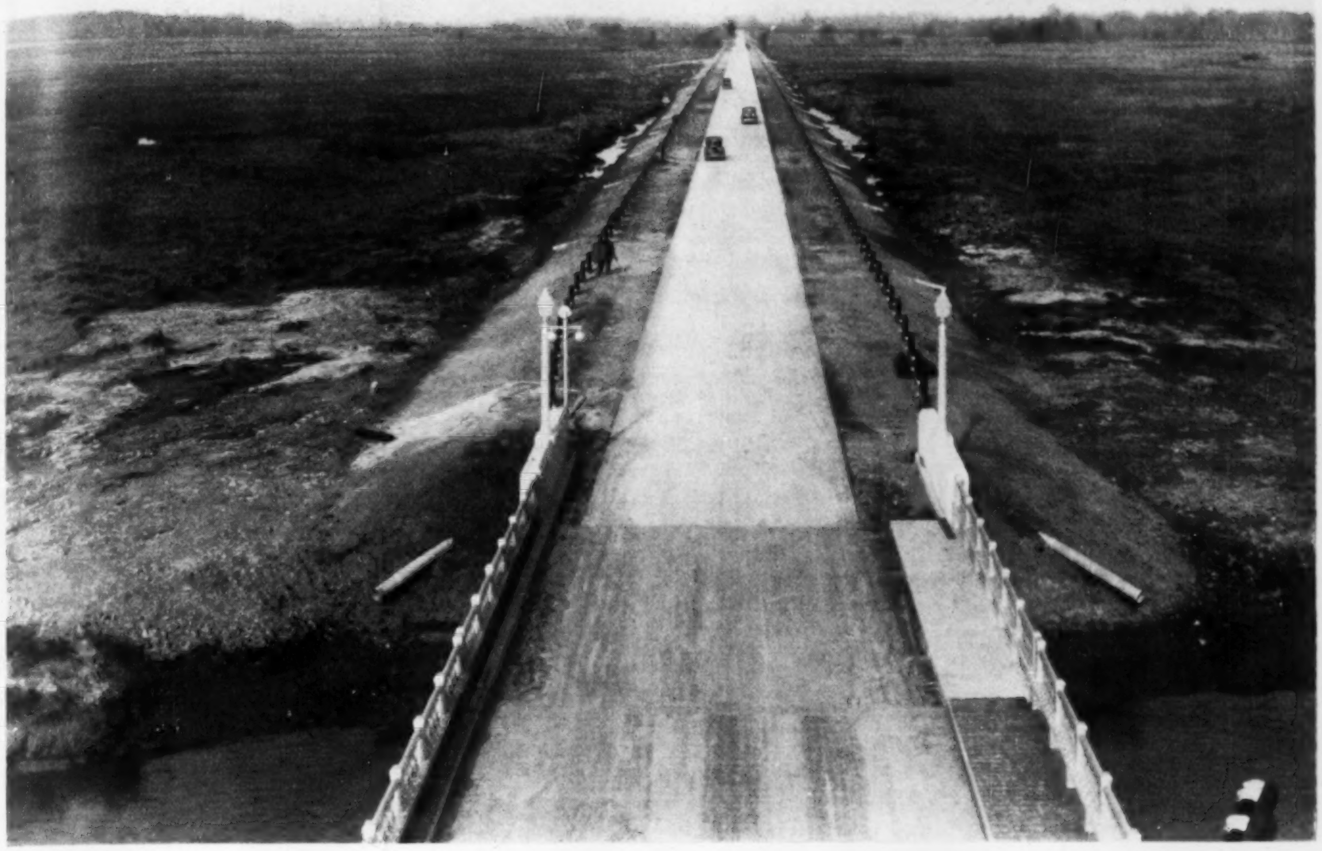


Fig. 4. A Modern Highway Traversing a Swamp
Permanent Pavements Have Been Made Possible by Improved Means for Settling Stable Fill Material to Solid Bottom

instances this method has failed to displace all the unstable material from beneath the fill, but it has been used successfully to settle fills up to 40 ft in width. It should be noted that even where unstable material has not been completely removed it may be trapped in such a way by the fill as to be in a state of equilibrium, and thus yield satisfactory results.

THE TOE-DUMP SETTLEMENT METHOD

In settling fills through shallow swamps, it has been found possible to use what is known as the toe-dump method of fill settlement, illustrated in Fig. 3. After the mat has been blasted, filling is begun at one end of the swamp, the material being piled as high as is commensurate with the depth of the swamp and the equipment for handling the fill. Holes are then punched down through the fill; explosives are placed; and the unstable material is blasted out from in front of the fill. The unstable material sometimes tends to pile up in front of the fill, and the Maryland Highway Department developed a unique method of removing this piled-up muck. Explosive cartridges are tied around 10-ft poles to form bombs, which are then pushed down into the muck and detonated. The muck is blown away from in front of the fill and the swamp is usually liquefied to some extent.

Where the only available fill material contains rock or large boulders, it is sometimes difficult to punch or even to drill holes throught it. The New Jersey Highway Department has developed a method for settling fill of this kind. After the mat blast has been made, case lots of explosive are placed in 3 rows, the units of the two side rows alternating with those along the center line. The cases are protected with railroad ties or planking, and the fill is then dumped on top. Care must be taken to use heavy, well-insulated wire in connecting these charges, with sufficient slack to prevent breakage of the wire under the weight of the fill before firing. Waterproof electric blasting caps and waterproof explosives are necessary with this method. Properly timed relief charges are as indispensable here as in connection with the wedge method.

SOME INTERESTING FACTS AND FIGURES

In all the methods described, original calculations for explosive charges should be made on the basis that 2 to 3 cu yd of unstable material will be displaced per pound of explosive. Forty to sixty per cent gelatine dynamite has had the widest use in this work. Waterproof electric blasting caps having enameled leg wires should be used.

The evolution of the fill settlement process has brought out may interesting facts. Holes of various sizes have been used for placing underfill charges, but in general the loading of small cartridges, through 2-in. pipe, which can be withdrawn afterward, has proved most economical. Loading by this method has been accomplished for less than 1 cent per cu yd of subfill placed; whereas loading through well drill-holes has cost as high as 9 cents per cu yd. Such wide variations in cost as these have caused differences of opinion in the past over the value of fill settlement work. Some actual cases will be interesting in this connection.

At one location a contractor started making the fill for

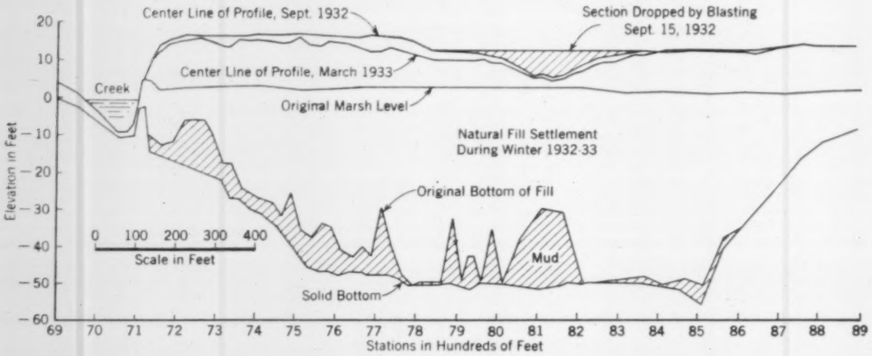


FIG. 5. SWAMP PROFILES FOR THE HIGHWAY PICTURED IN FIG. 4
Showing Solid Bottom, Original Marsh Level, and Road Elevations at Various Times Before Completion

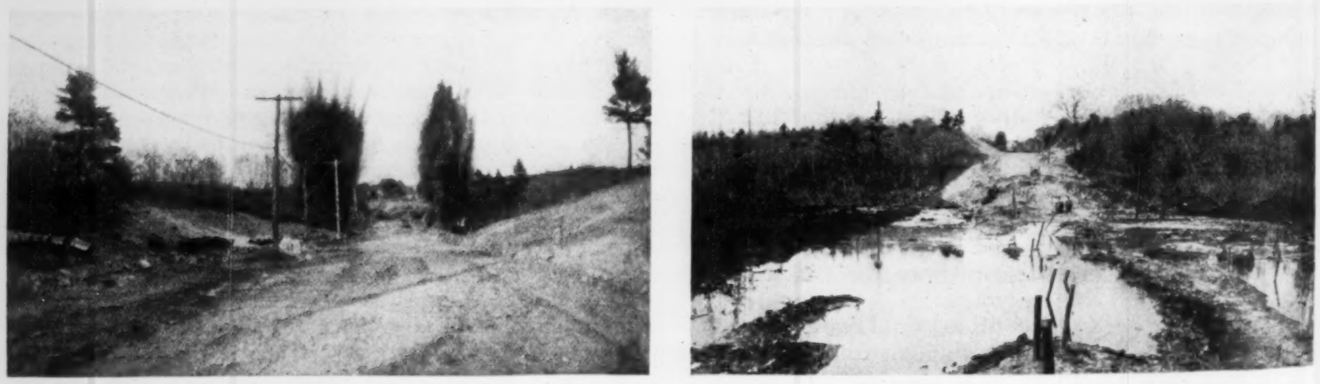
an approach to a new highway bridge already constructed. No thought had been given to fill settlement and no exploration of the subsurface had been made. As fast as the fill was placed, parts of it side-slipped beneath the surface of the swamp, and one morning the entire fill, including equipment, had disappeared beneath the surface. The road was finally dead-ended at the bridge. Preliminary exploration would have established the true condition of the subsurface, and controlled blasting would have given direction to the settling of the fill material.

In contrast to this is a fill settlement project recently completed, here illustrated in Fig. 4. In Fig. 5 a number of profiles taken on the center line of the road are shown. The original profile was plotted from actual soundings. The hatched area at the top of the fill represents settlement occurring when blasting was done in the large mud pocket, marked "mud," directly beneath. When this blasting had been completed, the hatched area at the top, representing settlement obtained, had an area within 5 per cent of the area hatched at the bottom, which represented the mud pocket before blasting. This swamp was more than 50 ft deep, and the road was 1,800 ft long.

In Fig. 6 (*a*) is shown a fill piled more than 20 ft above the water level of a swamp; Fig. 6 (*b*), from a photograph looking in the opposite direction, with the fill in the background, shows conditions immediately after the relief charges were detonated and before the underfill blasts took place. In Fig. 6 (*c*), taken from about the same point as the photograph in Fig. 6 (*a*), is shown the resulting drop of the fill to solid bottom. In Fig. 6 (*a*) the road follows an even grade over the fill to the house in the distance. In Fig. 6 (*c*) the difference in elevation between the house and the water flowing over the top of the fill may be noted. These pictures present visual proof of what can be accomplished through fill-settlement blasting.

(*a*) The Fill Is Piled More Than 20 Ft Above the Water Level of the Swamp. Holes Are Punched and Loaded

After nearly ten years of fill-settlement work, the results obtained by the use of the proper methods prove the practicability and economy of settling fills with explosives. The super-highways of the future will have to be fairly straight. Straight roads mean placing alignment in some cases on unstable material with consequent fill settlement. In deciding whether a road should go around or through unstable material, the cost of the right of way around the swamp as compared with that through the swamp is a factor. It should be possible to obtain swamp right of way very cheaply, whereas right of way through thickly populated districts is usually very costly. Thus in many cases swamp areas will provide economic locations for express high ways.


(*b*) Relief Charges Throw the Dirt High in the Air. Underfill Charges Follow. View in the Direction Opposite to (*a*) and (*c*)

(*c*) After the Blast the Fill Has Settled to Water Level. View Looking in the Same Direction as in (*a*)

FIG 6. A GRAPHIC ILLUSTRATION OF SETTLING A FILL EFFECTIVELY WITH EXPLOSIVES

Transportation of Sediment in Suspension

Some Practical Conclusions from Field and Laboratory Investigations

By LORENZ G. STRAUB

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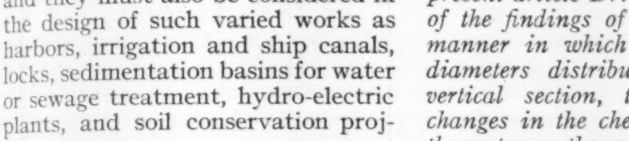
ALTHOUGH the principles underlying the transportation of sediment in suspension have been slow in yielding to mathematical analysis, considerable information of practical value on the subject has been obtained through research and experimentation. In the present article Dr. Straub outlines some of the findings of one such study—the manner in which particles of various diameters distributed themselves in a vertical section, the effect of certain changes in the chemical composition of the water on the mechanical composition of the suspended load, and the relation between the stream discharge and the quantity of sediment in suspension. He also touches briefly on the selection of a model law to insure similarity in laboratory studies of sedimentation basins. The material in this article formed part of the paper presented by Dr. Straub before the meeting of the civil engineering division of the Society for the Promotion of Engineering Education held at Atlanta, Ga., on June 25, 1935.

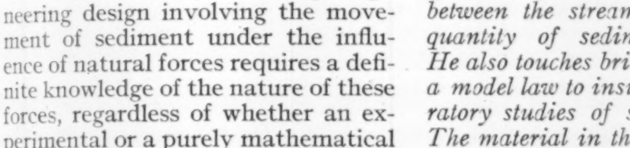
THE varied problems of transportation, erosion, and deposition of sediment are among the most important with which the hydraulic engineer must deal. Most of the work of river regulation is inextricably tied up with them, and they must also be considered in the design of such varied works as harbors, irrigation and ship canals, locks, sedimentation basins for water or sewage treatment, hydro-electric plants, and soil conservation projects.

A rational analysis of any engineering design involving the movement of sediment under the influence of natural forces requires a definite knowledge of the nature of these forces, regardless of whether an experimental or a purely mathematical treatment is undertaken. Among the more important are internal fluid friction, gravitation, and friction between solid particles.

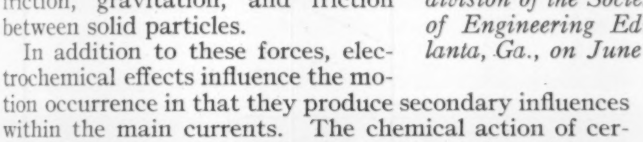
In addition to these forces, electrochemical effects influence the motion occurrence in that they produce secondary influences within the main currents. The chemical action of certain salts tends to cause the finer suspended particles to coalesce, thus changing the mechanical character of the suspension. Among the salts having this property may be mentioned those of calcium and magnesium. Other salts—for example, those of sodium and potassium—tend to disperse clusters of particles, again changing the character of the suspension.



(*a*) 40 Sec After Introduction of Dye



(*b*) 4 Min After Introduction of Dye



(*c*) 8 Min After Introduction of Dye

FIG. 1. PHOTOGRAPHIC RECORD OF AN EXPERIMENT ON A MODEL SEDIMENTATION BASIN

The practical importance of these phenomena becomes evident from study of the suspended loads of rivers and sedimentation basins. For example, in connection with an extensive silt study of the Missouri River basin, it was observed that the degree of dispersion of suspensions in the Missouri River at Omaha was frequently much greater than that of the same suspensions passing Kansas City, allowing due time for the flow passing one point to reach the other. As a result, much more difficulty is encountered with sedimentation in the water-purification plant for the municipal supply at Omaha than at Kansas City. It appears that the inflow between Kansas City and Omaha provides sufficient change of the chemical composition of the water to materially increase the degree of coalescence.

There are two major classifications of sediment-transportation problems: first, those in which the suspended material is of major importance, and second, those in which the motion of material along the bed is of primary importance. The amount of material transported in suspension by a stream is largely dependent upon the amount of finely divided material that finds its way to the stream. The quantity in suspension can be readily measured, but thus far there has been little success in defining mathematically the capacity of a stream for transporting material in this manner. The bed load, on the other hand, cannot be readily measured in natural water courses; however, it is believed that the theory of bed-sediment transportation—that is, the mathematical definition of the natural laws governing these phenomena—can now be set up with considerable accuracy. Further remarks at this time will be confined to a discussion of the transportation of sediment in suspension.

PERCENTAGE OF SOLID MATTER COMPARATIVELY SMALL

Ordinarily the percentage of solid matter contained in a silt-laden stream is quite small—usually not more than 20,000 ppm by weight, or about 2 per cent. The suspended load of the lower Mississippi, frequently considered a very muddy stream, seldom if ever exceeds 5,000 ppm; even that of the Missouri—the "Big Muddy"—seldom reaches 20,000. Exceptions may be found among such streams as the Colorado and some of its tributaries during flood stages, a few tributaries of the Missouri when subjected to cloudbursts, and possibly also the Rio Grande and the Yellow River of China during high stages. And there are, of course, special cases in which the limit is greatly exceeded; in the flow through dredge pipes for example, 15 to 20 per cent of solid material by weight will occur. On the other hand, the raw water that is fed into the sedimentation basins of water purification plants and sewage disposal plants usually contains far less than 20,000 ppm of solid matter.

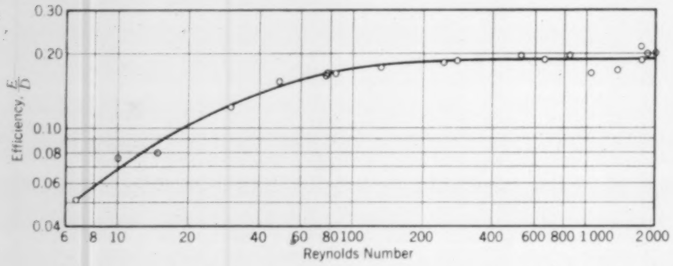


FIG. 2. RELATION OF EFFICIENCY OF MODEL SEDIMENTATION BASIN TO REYNOLDS' NUMBER FOR VARIOUS RATES OF FLOW THROUGH THE BASIN

It will be found in general, therefore, that the primary motion occurrences in a silt-laden stream are mainly dependent upon the flow conditions of the water as influenced by turbulence, deflecting works, and the like, and are ordinarily not greatly influenced by the secondary motion of suspended particles. Many problems of sediment transportation thus resolve themselves into an analysis of the flow conditions of the water in which the sediment is carried. This is particularly true in the study of deposition in off-channel harbors and in sedimentation basins.

MODEL SEDIMENTATION BASIN

Problems of this character frequently can be solved with the aid of properly designed small-scale models operated in accordance with a definite model law. A typical example of this type of analysis—the study of a sedimentation basin—is indicated by the results presented in Figs. 1 and 2. The work was carried on at the University of Minnesota. In Fig. 1 are shown pictorially the flow conditions as determined by successive photographs taken at intervals beginning at the time coloring matter was added to the influent water. By coloring the influent, beginning at a time after the flow condition through the basin has become stabilized, it is possible to observe the path of the water through the basin. Details of the direction and velocity of flow must of course be determined by direct observation rather than simply by photographs; however, the complete photographic record does give a method of comparison between various speeds of model operation, and permits some analysis of the effect of this speed upon the nature of the currents. In the experimental analysis the question arises immediately as to whether the model should be operated in accordance with the Reynolds model law, the Froude model law, or some other fixed relation.

In this case the relation of the efficiency to Reynolds' number was determined for various speeds of operation, the relative results being plotted as indicated in Fig. 2. Here the efficiency is the ratio of flow-through time to the detention period. The flow-through time is the interval necessary for the average particle to pass from the entrance to the exit of the basin along its circuitous route, and was determined by observation of coloring matter introduced at the entrance of the basin; the detention period was computed by dividing the capacity of the basin by the rate of inflow. For Reynolds' numbers greater than about 200, the model could be operated at any of a large range of velocities without affecting the efficiency—that is, neither Reynolds' model law nor Froude's model law had to be adhered to, inertia being the governing factor. These results were borne out by experiments on the prototype, the linear dimension of which was 7.25 times that of the model.

SUSPENDED LOAD OF RIVERS

It is generally known that the law governing the rate of fall of solid particles through still water is different for very small particles from what it is for larger particles. In the case of small particles, the viscosity as well as the density of the fluid comes into consideration, and the rate of fall is quite well defined by Stokes' law; here the resistance to fall is proportional to the first power of the velocity. For larger particles, Newton's law controls the relation between velocity and resistance to fall, the resistance being proportional to the square of the velocity. With water at a temperature of about 50 F, silt particles having a specific gravity of about 2.65 will follow Stokes' law up to diameters of about $^1/_{16}$ mm (0.0025 in.). For diameters greater than 1 mm, Newton's relation is closely followed, the viscosity and therefore the temperature of the water being relatively unimportant. Between these two limits there is a transition region.

In the light of the foregoing, the results of studies to determine the vertical distribution of suspended sediment in rivers are of considerable interest. Analyses of specimens gathered from the Missouri River at Kansas City at various depths below the surface of the water are summarized in Fig. 3. The samples so taken were analyzed for amount of suspended load per unit volume of water; furthermore, the mechanical composition of the suspended material was determined. It will be noted that the concentration increases with the distance from the water surface (Fig. 3); this is a normal condition, though in the study here presented the condition is rather exaggerated by the especially high viscosity of the water. (The observations were made in winter time.) Mechanical analyses of samples showed especially interesting relationships; the particles having diameters less than $^1/_{16}$ mm were quite uniformly distributed throughout the river cross-section, while those of larger diameters were very much more concentrated toward the stream bottom. This indicates a difference in the mode of transportation of the sediment in suspension, depending upon the nature of the material. It will be recalled that the fine particles follow Stokes' law with reference to the rate of sedimentation, the coarser ones Newton's law.

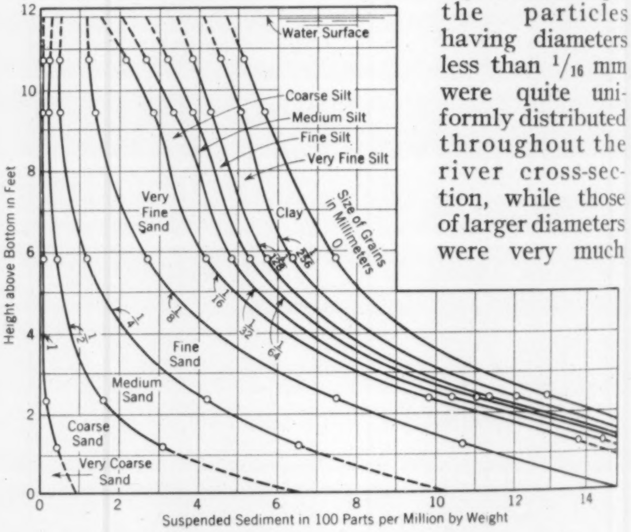


FIG. 3. VERTICAL DISTRIBUTION OF SUSPENDED LOAD AT A POINT IN THE MISSOURI RIVER AT KANSAS CITY

Although a wide variety of circumstances influences the amount of suspended material carried by a stream, the observation of the writer indicates that over a long period of time, at least for many rivers, there is a reasonably well-defined relation between the stream discharge and the amount of sediment transported in suspension. In Fig. 4 are presented the results of two years of continuous measurements (daily) of the suspended load of the Missouri River at Kansas City. Of course, the amount of material found in suspension on any particular day may deviate greatly from the average for the stage obtaining, depending upon the condition of the surface of the drainage area at the time, the location of concentrated precipitation in the area, and many other factors. This is well shown in the chart, the various plotted points giving the values for individual measurements. The equation for the curve for average conditions at Kansas City is $S = 30.42 \times 10^{-11} Q^{2.16}$, where S is the silt in tons per second, and Q is the water discharge in cubic feet per second. For other rivers, and even for other localities on the Missouri, both the coefficient and the exponent in the equation will be different from the foregoing. A comparison of the computed and measured suspended load of the Missouri River past Kansas City is presented in Table I. Although the daily deviations of the computed and measured values were great, it will be observed that the monthly figures are in close agreement.

TABLE I. COMPARISON OF MEASURED AND COMPUTED SUSPENDED LOAD CARRIED BY THE MISSOURI RIVER PAST KANSAS CITY

PERIOD	WATER DISCHARGE Acre-Feet	SUSPENDED LOAD, IN TONS	
		Measured	Computed
May 8–31, 1929	3,660,000	19,200,000	24,200,000
June 1929	10,600,000	153,000,000	151,000,000
July 1929	5,600,000	44,000,000	48,300,000
August 1929	2,180,000	6,660,000	6,190,000
September 1929	1,360,000	2,040,000	2,200,000
October 1929	1,730,000	3,900,000	3,410,000
November 1929	1,890,000	4,840,000	4,420,000
December 1929	916,000	1,050,000	878,000
Total, May 8–Dec. 31, 1929	27,936,000	234,690,000	240,598,000
January 1930	972,000	2,210,000	1,050,000
February 1930	2,040,000	8,740,000	6,890,000
March 1930	3,840,000	24,500,000	20,000,000
April 1930	3,460,000	18,500,000	15,900,000
May 1930	5,610,000	43,400,000	47,100,000
June 1930	4,370,000	31,400,000	27,600,000
Total, Jan. 1–June 30, 1930	20,292,000	128,750,000	118,540,000
Grand total, May 8, 1929, to June 30, 1930	48,228,000	363,440,000	359,138,000

RETENTION OF SEDIMENT IN SUSPENSION

Another question that frequently arises concerns the retention of sediment in suspension. A number of observations on rivers indicate that the material transported in suspension, particularly in heavily laden rivers, remains in suspension unless the flow is artificially retarded. A typical example of this is presented in Fig. 5. In this instance observations on the discharge of suspended sediment were made for about a month at two cross-sections of the Missouri River, at Kansas City and Waverly, respectively, about 80 miles apart. At these two stations the maximum and minimum suspended loads occur approximately one day apart in almost every instance. With a mean velocity of about 3 miles an hour, this would be the time required for the silt-laden water to flow from Kansas City to Waverly. The duration curves of the two stations for the silt discharge are almost identical, as are also the duration curves for the water discharge. Furthermore, although there was considerable variation in the character of the material from day to day, the mechanical composition of the finer grades of sediment gathered at the two stations on successive days was practically identical. These observations are in agreement with what might reasonably be expected, except for stretches where the river is in the process of changing its regimen.

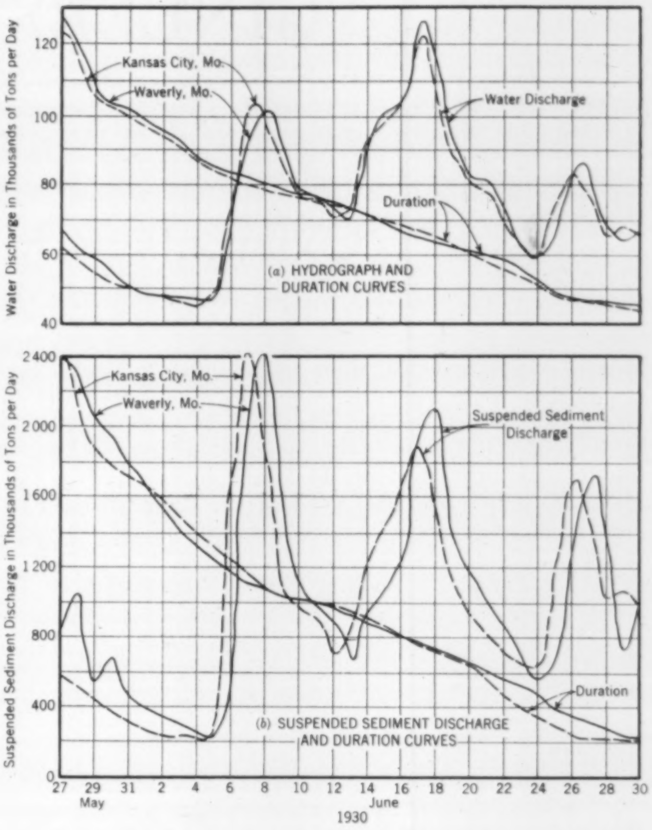


FIG. 5. HYDROGRAPHS AND SUSPENDED-SEDIMENT DISCHARGE CURVES FOR TWO STATIONS ON THE LOWER MISSOURI RIVER

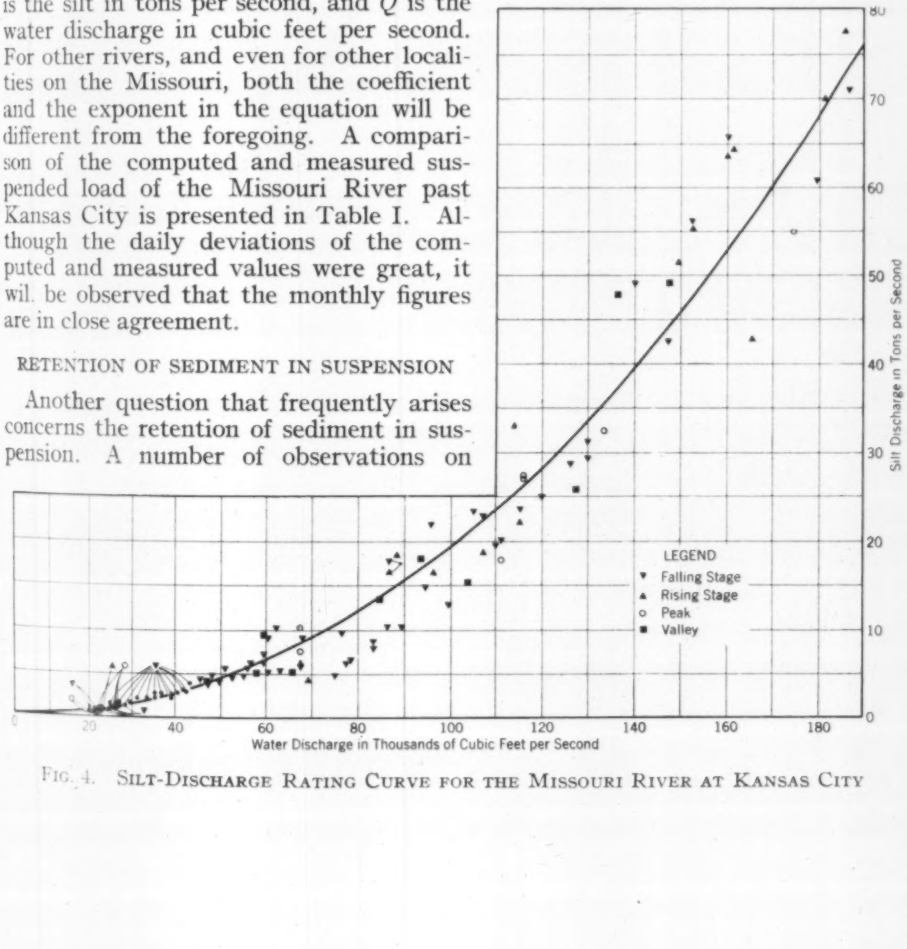


FIG. 4. SILT-DISCHARGE RATING CURVE FOR THE MISSOURI RIVER AT KANSAS CITY

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Comments on Rigid-Frame Bridges

By Arthur G. Hayden, M. Am. Soc. C.E.

Designing Engineer, Westchester County Park Commission, White Plains, N.Y.

THE problem of the skew barrel-arch or rigid-frame bridge seems to be a stumbling block to most of those who desire to use this type in preference to a girder bridge. A great many designers seem to be having difficulty in applying the skew-arch theory and in two instances have suggested evading the skew problem by constructing the frame as several independent, comparatively narrow strips, each of which could be analyzed as a square element. Each strip would be separated by joints from the adjacent strips. One arch bridge so constructed has, to my knowledge, resulted in failure. The designer had not taken into account, among other things, the lateral earth pressure of the spandrel fill (which in this case was considerable), and the failure was caused by a bulging of the outside strips.

Someone has suggested that the strips could be tied together by transverse tie bars to prevent the outward movement of the outside strips, apparently not considering that it would be difficult to tie the strips together laterally and still preserve their free, independent action. Moreover, the longitudinal expansion joints between strips would present difficulties with waterproofing. Finally, even if there is little or no spandrel fill on a flat-top skewed frame, still the couple produced by the horizontal earth pressure on the backs of the vertical legs of the strips must be resisted, and it should be apparent that some skew effects still exist.

The problem cannot be evaded by make-shift construction. There is, however, a limit below which the skew effects are undoubtedly insignificant. This limit cannot be definitely stated but the designer can feel reasonably safe, in the case of skews below 30 deg for bridges up to 40 or 50-ft square span, in proportioning the sections as for a bridge without skew, having a span equal to the skew span of the structure to be built. A small amount of transverse reinforcement, say 1-in. square rods top and bottom at intervals of 2 to 3 ft, will be sufficient to take care of torsional stresses within these limits. Later investigations may show this method of analysis to be sufficiently accurate for bridges of somewhat greater skew or span, but at present it is wise to take no risk. The design of heavily skewed arches or frame bridges should not be attempted by any but experts familiar with the principles of analysis.

STEEL FRAME BRIDGES

In my article in the August 1935 issue of Civil Engineering, the type of steel frame bridge built by the Westchester County Park Commission was illustrated. Both flanges of the girders for these bridges are curved and continuous around the bend at the knee (Fig. 1) and carry the stresses around the bend in a manner that can be approximately analyzed, although the problem is not nearly so simple as the design of a straight girder. The neutral axis does not lie at the center of gravity of section around the knee, but its location can be approximately determined, and the flanges (which will be unlike) can be safely proportioned. Bending effects in the outstanding legs of the flanges can be calculated and kept within proper limits by radial stiffeners bearing against or welded to the flanges. The proper spacing of flange rivets around the bend can be reasonably well determined, and the web stresses can be analyzed. Because the distribution of stress in the curved flange girders can be fairly well predicted and the girders designed to resist them, the Westchester County Park Commission has followed this design despite the fact that the expense of fabrication penalizes steel rigid-frame construction and increases the span at which it can begin to compete with concrete construction.

To simplify the fabrication of the frame girder, some steel frame bridges have been built in which the vertical legs have been designed as columns subjected to bending action from the horizontal section that frames into them. The general construction is shown in Fig. 2.

The deviations from normal conditions in the straight girder that occur in the curved section of the frame-bridge girder, causing the neutral axis to shift toward the center of curvature

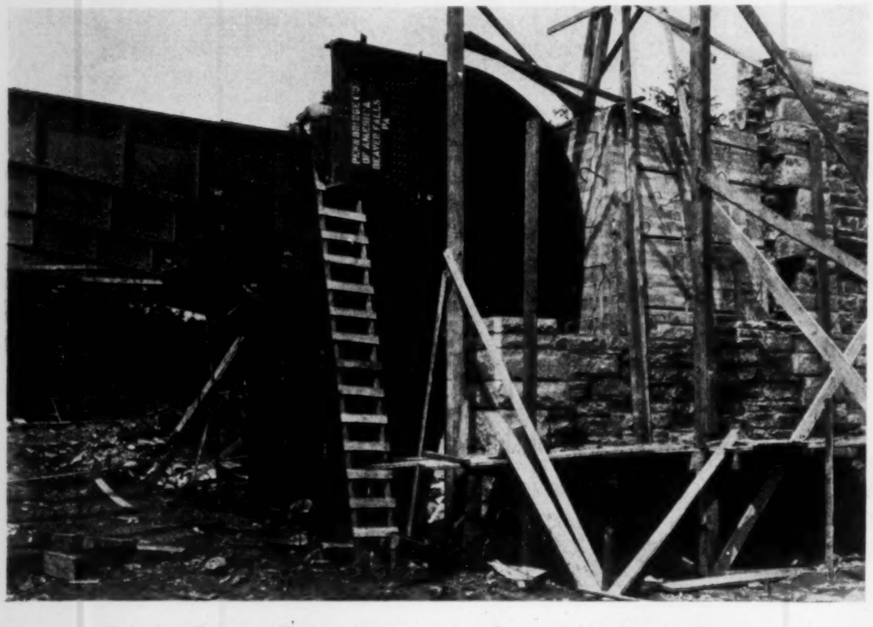


Fig. 1. Curved Flange Knee for a Steel Rigid-Frame Bridge

and introducing other new elements of design into the problem, may be called "disturbances," for lack of a better word. Reasoning by analogy from the "disturbances" that exist in curved-flange steel knees, it is not unlikely that "disturbances" exist in knees fabricated after the column-and-girder-connection pattern, but little is known about them at present. A photo-elastic analysis of stress distribution in a model of such a knee has been made in the physics laboratory at Columbia University, and the results indicate that the actual stresses are quite different from those calculated with the ordinary assumptions. The knee section of a steel frame bridge is not a minor detail but the most highly stressed and critical part of the structure. Failure here would mean a major collapse. In my opinion it will be wise for the designer to follow the curved flange design until more is learned about the true action of simplified steel knee sections, by experimental research.

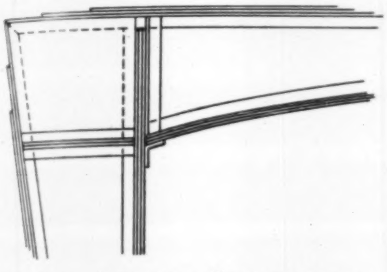


Fig. 2. A Possible Simplification of the Frame Girder Permitting "Straight" Fabrication

DESIGN OF THE STEEL RIGID-FRAME GIRDER WITH CURVED FLANGES

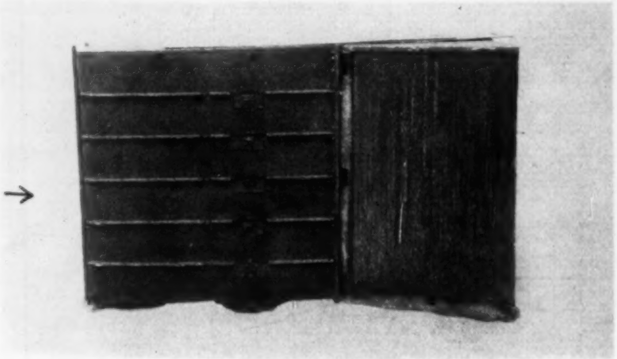
It is not usually convenient or economical to make the flanges of the curved section of the girders concentric. The exact analysis of the girder with non-concentric flanges has not, to my knowledge, been satisfactorily developed. The concentric beam or girder which it is possible to analyze is a special case of the more general problem that still awaits solution. The steel frame bridges built by the Westchester County Park Commission were designed by approximate methods that were on the safe side. The latest procedure is simply to make both flanges as nearly concentric as possible, select an outline with concentric flanges which, when superimposed upon the true outline, fits the case fairly well, and analyze the hypothetical detail by the method used for curved beams with concentric flanges. The calculation of such factors as flange stresses, bending in the outstanding legs of the flanges (from "curling" effects), rivet stresses, and web stresses follows directly. If the calculation results in a very light outer flange as compared with the heavy inner flange, the outer flange is arbitrarily increased to be sure of being on the safe side. The maximum size of the outer flange would be that calculated on the assumption that the neutral axis lies at the center of the section.

It is admitted that judgment developed by experience in structural analysis is an important element in the design of the curved-flange frame girder, but in my opinion the problems of design can be met with more certainty than in the case of the column-and-beam type of construction. There is certainly very little foundation for some of the assumptions made in the design of the latter, and the analysis of certain highly concentrated stresses is usually ignored. Different designers arrive at different results by their "rational" methods and by combining stress components at the knee in different ways.

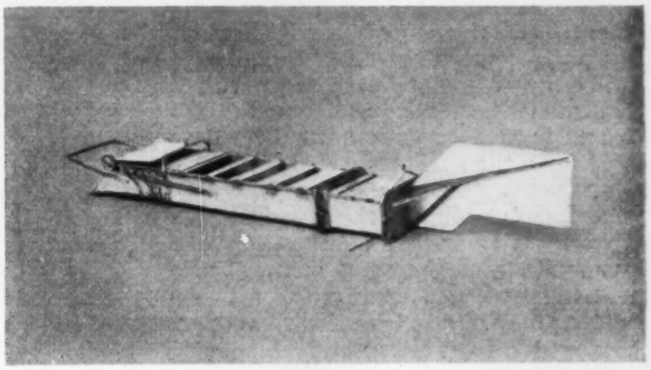
The Transportation of Sand by Wind

By Morrough P. O'Brien, Assoc. M. Am. Soc. C.E.
Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif.
and Bruce D. Rindlaub
First Lieutenant, Corps of Engineers, U. S. Army, Fort Belnoir, Virginia

Preliminary studies of the erosion of Clatsop Beach, at the mouth of the Columbia River, suggested that wind drift was an important factor. To establish the order of magnitude of this drift, a series of measurements were made under varying weather conditions. The experimental equipment and procedure were crude, but adequate for the purpose. Results were more regular than was expected at the outset, and they may be of some interest in connection with current studies of soil erosion. It is believed that no data on the relationship between wind velocity and weight of sand transported have been published previously.



The First Sand Trap Used on Clatsop Beach, Oregon
This Design Presented Too Great a Resistance to the Flow of Air and Was Abandoned



Sand Trap for River Bed Load Adapted to Wind Drift Studies
This Design Gave Results in Good Agreement with Those from the Riffle-Type Trap Finally Adopted

Air or water moving relative to a fixed boundary produces a tractive force which tends to move the boundary, and conversely the boundary tends to retard the motion of the fluid. The force just sufficient to set the sand in general motion—designated as the critical tractive force—probably depends upon the size, grading, angularity, and specific gravity of the grains of sand, the degree of compaction, the moisture content, the amount of cementing material present, and the slope of the surface. As the tractive force increases above the critical value, the grains first roll along the surface. With a further increase, the smaller grains begin to bounce (saltation), and finally a part of the material is thrown well up into the fluid and suspension is said to exist. The motion is generally accompanied by the formation of ripples whose dimensions depend upon the character of the sand and the tractive force, or the velocity. G. K. Gilbert, in "The Transportation of Debris by Running Water" (U. S. Geological Survey Professional Paper No. 86, 1914), has given a description of the various stages of motion in the transportation of sand by water which is believed to be basically true of transportation by wind.

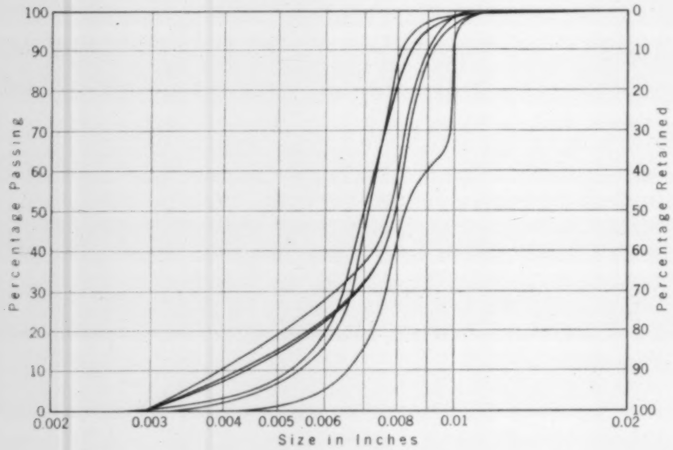


FIG. 1. TYPICAL SIEVE ANALYSES OF BEACH SANDS AT MOUTH OF COLUMBIA RIVER

Methods of correlating data on the transportation of sand by water are not generally applicable to wind drift, however, because such quantities as slope, depth, discharge per unit width, and tractive force are not directly measurable. The measurable variables connected with the transportation in air are the velocity and the velocity gradient. The tractive force may be computed from the velocity gradient by means of the equations for turbulent flow developed by Theodor von Kármán, M. Am. Soc. C.E., and Ludwig Prandtl, but the use of tractive force appears to be an unnecessary complication because use of the wind-drift measurements for predicting the annual rate of sand movement must necessarily be based upon the available meteorological data.

As stated previously, the experiments were intended only to establish the order of magnitude of the wind drift. The first sand trap used consisted of a box 3 ft long and 18 in. high, divided vertically into six compartments of equal height. Each compartment was fitted with a fine screen at an angle of 45 deg with the horizontal, below which was a shallow tray. This trap was found to present too great a resistance to flow. The air currents near the ground were altered in such a way that scour occurred at the windward end and a large percentage of the material rolling along the surface did not enter the lower compartment.

The trap finally adopted consisted of a rectangular trough 3 ft long and 6 in. wide, fitted with transverse riffles. A lip at the forward end prevented scour. The cover could be quickly removed or replaced. The trap was placed with its long axis pointing into the wind, and care was taken not to disturb the windward sand surface. At high wind velocities, an unknown amount of sand passed over this trap, but the runs with the first trap indicated that the concentration decreases very rapidly above the beach surface. It is believed that the amount passing the surface trap was only a small percentage of the total sand in motion. The manner in which the trap filled substantiates this view. The fill between the riffles started at the windward end, and as each space filled, sand began to spill over into the next one. The trap was closed before the last space had caught an appreciable amount of sand.

Another trap, which had been built for bed-load measurements in rivers, was placed on the beach during one of the runs, and the measured rates of movement were in good agreement with those secured from the riffle trap.

Wind velocities were measured during each run at points between 0.25 and 12 ft above the ground.

Sieve analyses of the sand caught in the traps and of the material from the surface of the beach showed variations in median diameter between 0.0065 and 0.0085 in. (Fig. 1). The predominant size is very nearly 0.008 in. The specific gravity is 2.65 and the sand is well rounded.

The measured velocity gradients (Fig. 2) showed some scattering in the slopes, resulting both from differences in thermal turbulence and from fluctuations in wind velocity during the runs. Measurements in the early morning when the beach is colder than the air should show a greater increase in velocity with height than those in the afternoon on a bright day. Observations confirmed this in the case of velocities lower than 15 ft per sec at 5 ft above the beach, but at higher velocities the effect of temperature on the velocity gradient was almost negligible.

The rate of sand movement was related to the wind velocity 5 ft above the beach. The measurements showed that when the velocity at this elevation was less than 13.5 ft per sec (9 miles per hr) no movement of the sand occurred, while movement was general at this velocity and above. This critical value is difficult

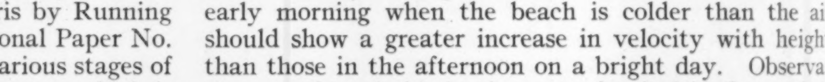


FIG. 2. WIND VELOCITY GRADIENTS DURING TYPICAL RUNS
The Measurements Were Taken with a Vane Anemometer

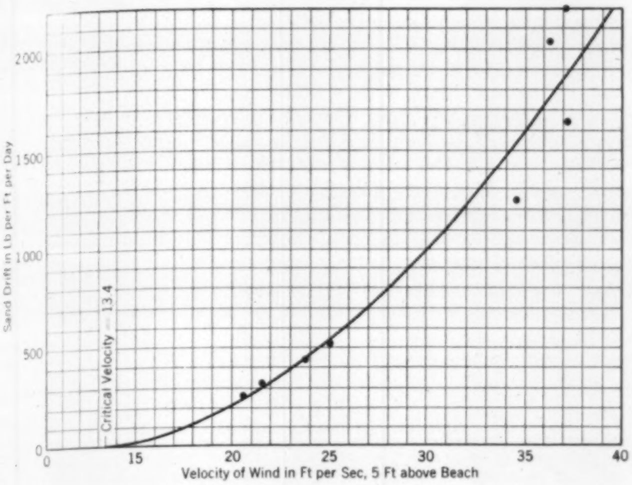


Fig. 3. Relation Between Wind Velocity and Rate of Sand Movement

to establish, because of gusts, but it is believed to be correct within 1 ft per sec.

In Fig. 3 the rate of movement is shown as a function of the velocity 5 ft above the beach surface. The smoothed curve drawn through the points corresponds to $G = 0.036\ V_5^3$ for values of V_5 greater than 20 ft per sec, where G is the rate of movement in pounds of dry sand per day passing an imaginary line 1 ft in length drawn perpendicular to the wind.

One of the objects of the experiment was to determine the effect of moisture on the wind drift, but this had to be abandoned because of the prohibitively large number of observations required and the difficulty of making quantitative determinations of the moisture content. It was observed that a wind having an intensity of 15 miles per hr moved sand in the moist area below the last high-water mark. On one occasion, sand was unpleasantly evident at 8 ft above the beach during a heavy rainstorm accompanied by wind with an intensity of 48 miles per hr. Following a rain, the beach surface dried out in from 30 min to 3 hours, depending on the wind intensity and relative humidity.

Many additional measurements on sands of different sizes under varying conditions of surface roughness will be necessary to establish generally valid relationships, but the results quoted are indicative of the magnitude of sand movement across beaches unprotected by vegetation.

Stadia Board for Long-Range Readings

By Gus. J. Swartz, Jun. Am. Soc. C.E.

Engineering Aide, U. S. Bureau of Biological Survey, Minot, N.D.

The stadia rod shown in Fig. 1 has proved useful to surveying parties of the U. S. Bureau of Biological Survey in North Dakota, because of the ease with which it can be read at long range. On many other types of rods the foot figures or markings are confusing, and when foot marks must be counted one by one between stadia hairs, mistakes are frequently made in reading distances and elevations. At the greatest distance at which a rod graduated to tenths can be read, the markings shown here are distinct, and there is no confusion between the numbers. Credit for the design is due Demming W. Morrison, Assoc. M. Am. Soc. C.E., formerly in the Minot, N.D., office of the Bureau of Biological Survey, U. S. Department of Agriculture.

Rods made in our office were of 1 by 4-in. pine boards, 13 or 14 ft in length, painted with one coat of white paint and one coat of white enamel. After the enamel was thoroughly dry the figures were scaled off with pencil, outlined with a ruling pen, and painted with black enamel. When this had dried, two coats of transparent varnish were applied for protection and waterproofing.

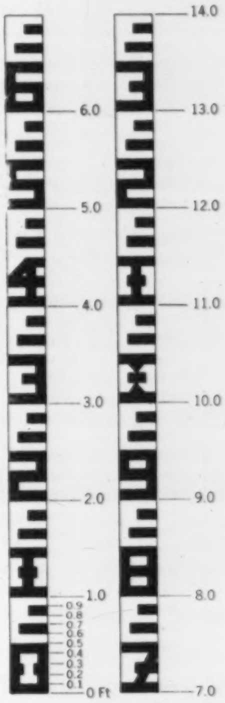


Fig. 1.

Bending Moment in Beams with Hydraulic Loadings—a Correction

Attention is called to a typographical error in the Engineers' Notebook item by J. C. Stevens, M. Am. Soc. C.E., on page 202 of Civil Engineering for March 1936. In Eq. 3, W should be w, the weight of a cubic foot of the loading liquid.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Permanency and Stability Important Planning Considerations

To the Editor: I was interested in the article on "The Future of Land Subdivision," by Harland Bartholomew, M. Am. Soc. C.E., in the March issue. The broad objective to be obtained through subdivision should be the better and more profitable use of land. Great stress has been laid upon the increase in ratables which subdivision and development bring, but very little has been said regarding the increased public costs that necessarily accompany such development as reflected in higher taxes.

Attention has been drawn to the lack of public control. As a natural reaction from the uncontrolled subdivision of land, there appears to be a definite trend towards a greater measure of legalized control, evidenced in New Jersey in the laws of 1930 providing for supervision and control of land subdivision by municipal planning boards, and in the recently enacted "County and Regional Planning Act." The latter act provides for control by county planning boards as well.

Accurate surveys, with definite location of the lots in them, are essential for the protection of the purchaser and for proper control of subdivision. Until recently the filing of maps of record and the proper monumenting of subdivisions were largely at the option of the subdivider. The enactment of zoning regulations is a further evidence of the trend towards the legalized regulation of the subdivision and use of land.

While the subdivider has been concerned primarily with the quick turnover and sale of the land, public officials and the developers themselves must, today, be more concerned with the problem of keeping the land sold.

Many of the existing subdivisions where a majority of the lots are vacant and tax delinquent, show a large percentage to be of the type comprising narrow lots—of 20-ft, 25-ft, and 40-ft frontage—generally of the "regular," or "gridiron," type. Today there is a definite trend towards the use of larger frontages (wider lots) and more irregular layouts.

Concern in permitting the subdivision of lands should be based on necessity and on the character of the proposed subdivision, in order to insure permanency and stability. Permanency and stability—a long-continued use of a given tract of land for a stated class or character of occupancy—can be attained only where legalized control is provided and where intelligent planning is employed.

This motor age has provided new opportunities for land subdivision and development, but at the same time has imposed a heavy liability on the developer and planner, and the communities through which the arteries for traffic have been constructed. It is now generally recognized that these traffic arteries have a depreciating effect upon the frontages of the lands through which they pass, such depreciation often extending a distance of several hundred feet on either side of the highway. If considerable areas along the highways are not to be abandoned except as open spaces, a means of protection must be devised.

In the interest of safety, and to keep thoroughfares free for moving traffic, access to and entrance upon such highways should be prohibited or discouraged except at controlled points. Constructing local streets parallel to main highways in such a way as to provide access to the lands accomplishes this and permits a better utilization of the land. The erection of walls along the highways at the property line, to a height of 9 ft or more, offers an effective protection and permits full utilization of the land. Such walls will, in most cases, be found more economical than other forms of protection entailing little or no cost for maintenance or upkeep as compared with park strips or other methods of protecting the lands. The wall also provides a visible limit which enables the public to see a local community as such and recognize it as a distinct entity.

HENRY O. POND, M. Am. Soc. C.E.
Chairman, County Planning Board
County of Bergen

Tenafly, N.J.
April 3, 1936

The Design of Stadium Structures

TO THE EDITOR: The article on "The Bessemer High School Stadium" by W. N. Woodbury, in the December issue, has interested me very much. The welded steel plate deck which he describes is a new development that should be of general value for stands with weather-tight decks for which low first cost must be of paramount importance. The provisions for rapid erection and for complete field welding from above are especially noteworthy and commendable.

Some of the author's statements of general principles of stadium design deserve comment.

He says that, "Stadium decks are generally designed for a total load of not over 110 lb per sq ft" and that, "A stand loaded to capacity carries an average live load of 40 lb per sq ft."

These are, I believe, dangerous statements. In the first, even if a total live load is meant, provision for a load of 110 lb per sq ft is still inadequate. In the second, it must be presumed that the live load of 40 lb per sq ft is intended to refer to a "stand loaded to capacity" by seated spectators only, with no crowding, and no extra spectators standing. Such a figure is of academic interest only, because if a stand were designed on this basis one extra spectator passing along an occupied row would form an overload.

As a member of the Committee on Safety Code for Grandstands of the American Standards Association, I have consistently urged safe live load assumptions in design, recommending not less than 125 lb per sq ft for the usual case.

Mr. Woodbury does well to point out the importance of seat design. The seat is a unit on which the design of the entire structure hinges, repeated over and over, usually thousands of times, in the same stand. The type of seat which has a full overhang, as shown in Mr. Woodbury's Fig. 2 (*c*), has the greatest possibilities for efficient compromise between the saving of space and the comfort of the spectators. A useful improvement would provide for the support of the seat entirely from the face of the riser, as in numerous structures built during the past twelve years.

I must disagree with Mr. Woodbury's statement that, "The best site is a high level area. . . ." More often than not, a site which permits the construction of a large proportion of the deck directly on earth cut and fill is better than a level site. Supplementing his statements regarding orientation of the field of play, it should be noted that the longitude of a site has far greater influence than the latitude on the ideal orientation.

I question the justification of the use of a smaller sight-line clearance for small stands than for large stands; also, a clearance of 6 in. for either small or large stands seems excessive. A clearance of 4 in. has proved to be satisfactory in numerous stadia, some of which have decks more than 75 rows wide.

Mr. Woodbury has in general correctly described the seats most desired by the average spectator at a football game. The crescent type of stadium to which he refers was developed from my analysis of these seat preferences (see "Influence of Loci on Engineering design," in the December 1934 issue of CIVIL ENGINEERING).

With regard to a "horizontal curve in the stadium structure," it is perhaps more accurate to say that, in the usual case, curving the rows of seats at the sides of the gridiron will result in placing the seats near the 50-yd line farther from the center of the field—not in reducing the distance to the end seats.

GAVIN HADDEN, M. Am. Soc. C.E.
Civil Engineer

New York, N.Y.
April 3, 1936

Preserving Bench Marks

DEAR SIR: The U. S. Coast and Geodetic Survey has established, throughout this country, considerably over 100,000 bench marks, the elevations of which have been determined by means of either first- or second-order leveling. Although every effort has been made to place these bench marks in permanent locations, it is inevitable that some of them will have to be moved because of new construction or repair work or other reasons. While it is desirable that an established bench mark be maintained in its original position and at its original elevation, it is better to relocate it and transfer the elevation from the old mark to the new one rather than to destroy it.

The Coast and Geodetic Survey has no funds available for relocating marks which must be moved to make way for new construction. However, since these marks are established not only for the use of this and other government bureaus, but for the benefit of all engineers and surveyors, it is reasonable to expect that they will cooperate in preserving them. A routine method for handling cases of this sort has been worked out, and if engineers will cooperate, as outlined, the destruction of useful bench marks will be greatly reduced.

When it becomes known that a mark must be moved, a letter should be sent to the director, U. S. Coast and Geodetic Survey, Washington, D.C., marked for the attention of the Section of Leveling, stating the necessity for moving the mark and giving its designation. The designation of a mark consists of the letters and numbers stamped on the disk with dies. It is desirable to furnish a rubbing of the disk as well. A rubbing may be made by placing a sheet of light-weight paper over the disk and then rubbing over the paper with a hard pencil to bring out the legend cast in the disk and, especially, the letters and numbers stamped on it with dies. Enough of the disk should be rubbed to show its type and the organization which established it.

Upon receipt of this information, this office will send out a new disk properly stamped to show that it has been reset. Instructions will also be given for the establishment of the new mark and the transfer of elevation to it from the old one. Usually the procedure is to establish the new mark in a safe place nearby and to transfer the elevation from the old mark to the new one by means of an engineer's level and rod. The levels should be run in duplicate to avoid the possibility of large errors, and the readings should be made to three decimal places to preserve the accuracy of the original elevation. An assumed elevation may be used for the old mark in making the transfer of elevation, since at that time the primary concern is the difference in elevation between the old and new mark. After the elevation has been transferred and checked, the old disk should be broken out and returned to this office in a franked mailing sack which will be provided for the purpose.

Upon the establishment of the new disk and the transfer of elevation to it, a complete report should be forwarded to this office, in a franked envelope provided for the purpose, giving a description of the location in which the new mark was established, a copy of the field notes involved in the transfer of elevation, and any other pertinent information. This report should be so complete that anyone in this office, totally unfamiliar with the action taken, may be able to follow it through.

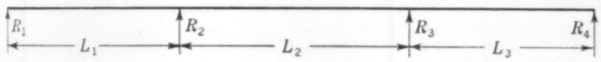
This cooperation in preserving bench marks will be a service not only to this and other government organizations, but to any engineer who may have occasion to use the marks. Such cooperation will doubtless prevent a large number of marks from becoming totally destroyed and thus rendered useless to the profession.

Howard S. Rappleye, Assoc. M. Am. Soc. C.E.
Chief, Section of Leveling, Division of Geodesy, U. S. Coast and Geodetic Survey

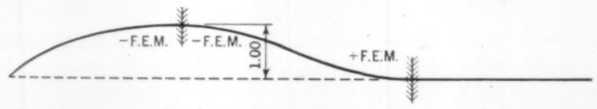
Washington, D.C.
April 6, 1936

Further Simplification in Computation of Influence Lines

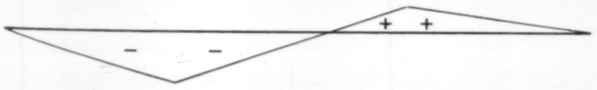
To the Editor: The article on "Simplified Solution of Influence Lines for the Reactions of Continuous Beams" by V. L. Pierce, in the December issue, is clearly written and emphasizes the not too well-known application of Müller-Breslau's principle regarding influence lines. I should like to point out a more direct application of this same principle to the same example that he used, as shown in Fig. 1 (*a*).



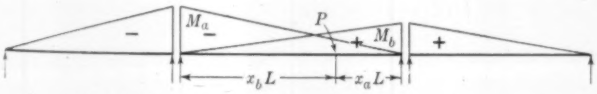
(*a*) Continuous Beam $R_1R_2R_3R_4$



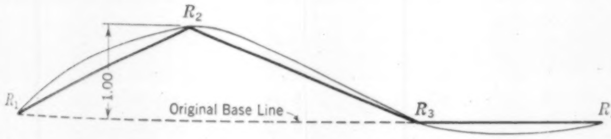
(*b*) R_2 Displaced Unit Distance, Joint Rotation Prevented



(*c*) Moment Diagram Due to Displacement of R_2



(*d*) Triangular Loads on Conjugate Beams



(*e*) Moment Curves for Loads in (*d*) Superimposed on Deflected Base Line $R_1R_2R_3R_4$ (Influence Line for R_2)

Fig. 1. Influence Line for R_2

If the reaction R_2 is displaced a unit distance, the resulting deflection curve will be the influence line for the reaction R_2. This is the Müller-Breslau principle briefly stated. This curve can easily be found by the following steps:

1. Displace R_2 a unit distance holding joints at R_2 and R_3 against rotation, Fig. 1 (*b*).
2. Compute fixed-end moments, and distribute by principles of moment distribution.
3. Draw moment curve, or if EI is variable, draw M/EI curve, Fig. 1 (*c*).
4. Consider moment curve as load on conjugate beam. For the conjugate beam, the end conditions at R_2 and R_3 are pins, corresponding to the continuity in the actual continuous beam. Thus the conjugate beam can be considered as three simple beams, loaded with M/EI curve of Fig. 1 (*c*). See Fig. 1 (*d*).
5. Calculate the moment curve due to the loading for each simple beam. The moment curve superimposed on the new deflected base line, $R_1R_2R_3R_4$ (in which R_2 is at the displaced level, and the other three supports are at their original level), will be the deflection curve, or by the Müller-Breslau principle, the influence line for R_2 as shown by the curved line in Fig. 1 (*e*).

The influence line for R_1 can be found similarly.

The actual calculation of the moment curve in the conjugate beam presents the greatest difficulty. If the beam is of constant EI between supports, however, the problem becomes one of finding the moment curve due to two triangular loads, as shown in Fig. 1 (*d*), center span. The actual beam deflection at any point P due to M_a, is

$$Y_a = \frac{M_a L^2}{6EI}(x_a - x^3_a)$$

in which x_aL is measured from the zero end of the M_a curve. At the same point, the deflection due to M_b is

$$Y_b = \frac{M_b L^2}{6EI}(x_b - x^3_b)$$

in which x_bL is measured from the zero end of the M_b curve. That is,

$$x_a = (1 - x_b).$$

The net deflection due to the combined triangular loads is obviously

$$Y = Y_a + Y_b$$

The value of $x - x^3$ is tabulated for values of x between zero and unity, in increments of 0.01, in *Statically Indeterminate Stresses* by Parcel and Maney, page 173, Table III.

The particular advantage of the procedure outlined herein is that it removes the necessity for calculating the simple beam deflections of the entire length of the continuous beam, which process in the case of non-uniform sections may involve tedious arithmetic. Also, in the case of many supports, the additional supports add to the difficulty in the method outlined by Mr. Pierce. In the method herein presented, since the moment curve in distant spans becomes increasingly smaller, the influence line for R_2 or R_1 may become negligible, and possibly need not be considered. At least the influence line in these distant spans can be closely approximated by finding the value at the center of the span from the formula

$$Y = \frac{L^2}{16EI}(M_a + M_b)$$

and sketching in the remainder of the curve.

For other applications of this same general method to influence lines for shears and moments, see Cross and Morgan's *Continuous Frames of Reinforced Concrete*, Chapter VIII.

Lewis K. Oesterling
Aluminum Company of America

Pittsburgh, Pa.
April 3, 1936

Construction of Portable Hydraulic Laboratory

TO THE EDITOR: In connection with my article on "A Portable Hydraulic Laboratory," in the April issue, I have had several requests for detailed information about various parts of this laboratory. I wish to emphasize the fact that the mechanical excellence of the finished product is entirely due to the knowledge and skill of George Bourdelais, our superintendent of shops. Without his interest and cooperation, the portable hydraulic laboratory would have been a very ordinary affair. Information regarding the construction of this apparatus will be gladly given if inquiries are addressed to Mr. Bourdelais or the writer.

SCOTT B. LILLY, M. Am. Soc. C.E.
Professor of Civil Engineering
Swarthmore College

Swarthmore, Pa.
April 10, 1936

Garbage Reduction in Indianapolis

TO THE EDITOR: In connection with the article on "The Disposal of Garbage with Sewage," by C. E. Keefer, M. Am. Soc. C.E., in the March issue, I should like to comment on this problem in Indianapolis. No method of waste disposal is entirely satisfactory either on account of cost or offensiveness. It is safe to say that no unsubsidized garbage reduction plant is a financial success, and destructive disposal methods are so expensive that cheaper methods are sought.

The plan of disposing of garbage with sewage is less revolutionary than appears on first thought. All kitchen waste which will pass the sink strainer goes to the sewer. As Morris Cohn has pointed out, many people put rather large scraps of waste food through the toilet. Thus the addition of garbage to sewage introduces no new item, but it does increase the concentration of organic matter of this sort. The nature of garbage varies in different cities. The inclusion of rubbish and ashes makes it less desirable in sewage, and special provision for handling it is required.

Indianapolis garbage is especially free from rubbish for the reason that a by-product plant has been operated for more than twenty years, and a constant effort is made to exclude other than actual food waste. Even so, some 35 lb of inert material is recovered per ton of green garbage. This consists of bone, egg shell, metal, coffee, and glass in the order named. Observations made on a number of days lead to the estimate that some 3,500 dozen egg shells are put into Indianapolis garbage daily. During the 31 weeks from May 13 to December 14, 1935, more than 17,000 tons of garbage were ground with a Jeffrey hammer mill and added to the sewage. On the peak day 190 tons were handled. The sewage flow averaged about 45 mgd.

In studying the effect of garbage on sewage, it became necessary to develop sampling methods applicable to raw garbage and sewage. As a result, checks of within 6 per cent were obtained in the determination of suspended solids, total solids, oxygen consumed, bio-chemical oxygen demand, total organic nitrogen, and petroleum ether soluble on samples of sewage through the clarification process. Fine grinding, achieved by using $^1/_2$ or $^3/_8$-in. spacer bars, reduces the floating material to a negligible amount. The grit is freed of much of the organic matter and thereby reduced in amount. Removals are as good, at least, as when the grinding is coarser.

While the garbage has been added to the sewage, the clarified sewage has been treated by the plain aeration process and by the activated sludge process. The operation of neither process has been disrupted by the garbage, and removals are comparable with periods when sewage was treated alone. There has been no measurable increase in the organic load discharged to the river.

There has been no increase in the number of attendants operating the plant, or in the amount of air required for aeration of the sewage. Sludge has been pumped to the same open digestion pits used since the plant started, and no trouble is apparent at this time.

C. K. CALVERT
Superintendent, Garbage Reduction and Sewage Disposal,
City of Indianapolis

Indianapolis, Ind.
April 2, 1936

Rôle of the Engineer in Lessening Occupational Hazards

TO THE EDITOR: The following comments are made on the paper by C. L. Pool, Assoc. M. Am. Soc. C.E., on "A New Field for Sanitary Engineers," in the March issue.

The field of industrial sanitation includes three major divisions: (1) Sanitation of buildings of the workers, including provision of safe water supply, sewage disposal, clean quarters, and adequate lighting and heating; (2) elimination of conditions tending to promote accidents to workers; (3) control of plant processes whereby harmful vapors, liquids, and other irritants may cause damage to the human body. In the first of these fields, the sanitary engineer should be qualified without additional training. His general engineering training should assist him in the second field, although in his own particular work in water supply and sewage disposal he has not distinguished himself in eliminating tendencies for accidents. The third field is a highly important one, and here the sanitary engineer needs specialized training and cooperation with physicians.

Silicosis and one or two sister maladies do not represent the limit of occupational diseases encountered, as evidenced by the fact that studies by the bureau of occupational diseases of the Connecticut State Department of Health have disclosed approximately 700 hazardous occupations in about 100 types of industry within the state. This bureau is headed by a physician who has as assistants two industrial chemists, and it is hoped that it will soon be possible to add a mechanical engineer to the staff.

When the bureau was organized in 1927, its first task was to ascertain what occupational diseases existed. This required a physician's knowledge and the establishment of close relationship with the doctors in the state to ensure the reporting of occupational diseases. With the data thus accumulating, clinical observations and laboratory studies and tests were begun, to determine what substances and degrees of exposure were the cause of illness. Manufacturing operations in the field were changed as rapidly as knowledge of remedies was available. As changes have been made, clinical observations and disease statistics have been needed as correlative evidence of improvement.

Basically, of course, any broadly trained engineer—whether a civil, sanitary, mechanical, or chemical engineer—any broadly trained chemist, or any broadly trained physician can contribute to industrial sanitation work. Practically speaking, all three groups require specialized training to contribute their utmost. As Mr. Pool has ably outlined, the sanitary engineer may have a real place in industrial sanitation work. Certainly in the first two fields just mentioned—building sanitation and accident prevention—he can almost single-handedly bring about major improvements. In the last-named field—control of plant processes involving poisons and irritants from vapors, liquids, or other sources—without special training, he is at a disadvantage with a trained chemist, chemical engineer, or sometimes a mechanical engineer. The sanitary engineer contemplating extensive industrial sanitation work should recognize his limitations as well as his qualifications and make up his deficiencies.

It seems appropriate to mention that, in any grouping of hazardous occupations, the operation of sewage treatment plants and even of water treatment plants is listed. Yet too little thought and attention have been devoted by many designing and supervising sanitary engineers to the existence of these hazards, which might be divided into three groups: (1) Hazards from lack of air or the presence of toxic gases; (2) hazards from explosion; and (3) hazards from accidents. In specifying equipment for new plants, in designing structures to reduce danger of accident, and in supervising water and sewage plant operation, the sanitary engineer can do much toward eliminating occupational hazards, and to prove his worth in the industrial sanitation field he should increasingly recognize hazards in his designs and in operations under his direction.

WARREN J. SCOTT, M. Am. Soc. C.E.
Chief Engineer, Connecticut State Department of Health

Hartford, Conn.
April 9, 1936

Core-Drilling on Dover Dam

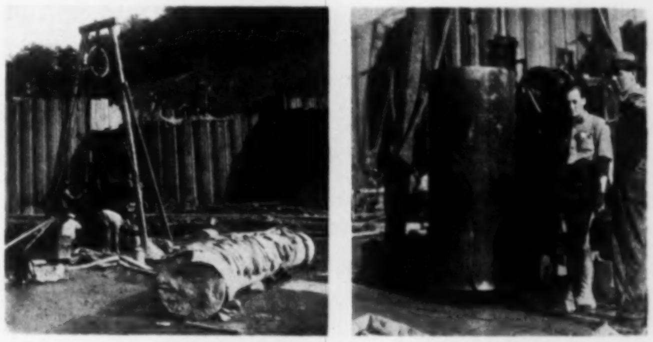
To the Editor: In the article on "Construction Methods at Norris Dam," by Ross White, M. Am. Soc. C.E., in the December 1935 issue, reference is made to the use of 36-in. test borings on this project. Similar borings were made at Dover Dam, one of the fourteen dams on the Muskingum project, to facilitate observation of undisturbed foundation rock.

Dover Dam, a gravity-type concrete dam with a volume of 100,000 cu yd, is located approximately on the crest of a gently dipping anticlinal arch. The foundation rock underlying the main part of the dam consists of 4 ft of hard, dense limestone underlain by some 4 ft of carbonaceous shale which grades downward into a sandy silt shale. The sandy silt shale becomes increasingly sandy with depth and rests on a medium hard, fine sandstone at 35 to 40 ft below the foundation surface. In addition to numerous approximately vertical joint cracks occurring in the foundation rock, several steeply pitching faults, along which rock displacement of a few inches has occurred, cut the foundation along a strike roughly parallel to the center line of the dam. These faults are confined mostly beneath the downstream apron of the dam.

Two 30-in. test core borings were drilled in the foundation rock. One hole was drilled to a depth of 30 ft in the undisturbed rock, while the other hole was located a few feet from a fault and drilled to a depth of 15 ft so as to intersect the projection of the fault plane.

Because of the disturbance of the core material during removal from the hole, together with considerable disintegration of the shales on exposure to the air, an accurate determination of the undisturbed condition of the foundation rock could not be ascertained from a study of the core. However, a continuous flow of seepage water down the face of the core hole prevented disintegration of the rock in place.

An observer lowered into the drill holes was able to study the undisturbed rock and to definitely ascertain that the joint cracks in the limestone cap are more or less entirely confined to that stratum and do not extend into the underlying shales. Scattered open horizontal partings occur in the bedding planes of the shales. These open partings could not be detected in the cores. The fault planes which are well defined and slickensided in the limestone cap, are represented in the underlying shales as shattered zones some 2 ft wide along the projections of the fault planes. The rate of flow of water from the individual rock fractures and partings at various depths could likewise be studied and the effects of preliminary grouting to dry up surface seepage determined.



Rig for Drilling — Bit Used in Operation

Making 30-In. Holes and Core for Dover Dam Cofferdam

Observations of the undisturbed foundation rock were very helpful in governing a grouting program. The depths to which grout holes are to be drilled and the proper consistency of the grout mixes depend to a large extent on the knowledge gained through studies made of the undisturbed rock in these holes. It was our experience that the 30-in. size was ample for the purpose. These holes should cost from $15 to $30 per foot of length, depending on the nature of the rock and the amount of drilling. Prices will be higher where less than 200 ft of holes is drilled. It is believed that these holes are a worth-while measure in studying the foundation problems of important dams.

T. T. Knappen, Assoc. M. Am. Soc. C.E.
Senior Engineer and Chief, Engineering Division, U. S. Engineer Office

Zanesville, Ohio
March 20, 1936

Specifications Should Require Services of Contractor's Engineer

To the Editor: A study of contracts and specifications prompts me to ask, "Do engineers write specifications and contracts?"

Contracts for public works require the contractor to acknowledge and agree that he fully understands all the requirements of the contract. Specifications are so written that only a professional engineer is qualified to interpret them. Engineering information necessary for completion of the contract requires professional engineers if the contractor is to assume, fairly, the responsibility stipulated. Schedules of work require engineering principles and practice, without any or with only blanket provisions for approval of method or design. The contractor is required to furnish designs which should be done by a qualified professional engineer who is (1) held responsible for his designs, (2) required to sign contractors' drawings, and (3) required to supervise erection and maintenance.

During construction new problems, which too often must be met immediately, develop. There is no specific provision for the immediate necessity for qualified professional knowledge, advice, and instructions, and responsibility for the proper execution of these instructions. The generalities on this point do not compare with the well defined limits of "Concrete," "Bonds," or "Payments."

There should be a professional engineer, with authority stipulated in the contract, at the site of each principal operation. He should be required (1) to be responsible for all engineering factors developed during construction and (2) to plan and submit for approval any changes or revisions which conditions require. Every contract should require the presence of at least one professional engineer at each important working point, for engineering safety.

All contracts should require the contractor to name, at the time the contract is signed, a professional engineer. This engineer must certify, with the contractor, that he has been engaged to represent the contractor in all engineering matters; that he has examined the site, specifications, and drawings; and that he has made the necessary engineering investigations to prepare the estimate for bidding. Contracts should require the contractor's engineer to certify, before final payment is made, that all engineering requirements have been fulfilled and that the completed work is in accordance with the contract and specifications.

Including these requirements will put contractors on the same basis for bidding this part of the costs; will eliminate unnecessary claims of not understanding requirements; will permit all necessary engineering work with a qualified representative of the contractor; and will specifically provide for adequate engineering responsibility, on the part of the contractor, for the protection and safety of the public life, health, and property.

Contractors doing the few big jobs, do employ engineers. But there are no specific requirements for their qualifications or their duties, nor is there any definition, in the contract, of their authority or responsibility. Contractors doing work on the smaller jobs do not, as a rule, retain professional engineers. It is not reasonable to expect contractors to engage such engineers, if the engineers themselves permit contracts to be released which necessitate considerable professional engineering, at the same time making no provision therein for the authority and responsibility of the contractor's engineer, nor requiring either that the contractor be a qualified professional engineer himself or that he engage one for the work.

If engineers do write specifications and contracts, they should include clauses which will make sure that the contract provides for adequate qualified interpretation and establishes responsibility for all engineering requirements of the contractor. Contracts for private work, which include these provisions, will enjoy the same advantages as contracts for public work.

Thomas J. Graham
Construction Engineer

Woodhaven, N.Y.
March 29, 1936

Defending the Salt Water Barrier

TO THE EDITOR: The article on "Combating a Saline Invasion in California" by Edward Hyatt, M. Am. Soc. C.E., in the September number, affords a straightforward, comprehensive summary of the menace of salinity, its development along with increased consumption of water, and plans proposed to combat it in some of the most productive lands under cultivation in this country. Discussions contributed by various members or leaders of the engineering profession display the usual diversity of opinion concerning details of the alternate plans thus far proposed and their relative feasibility. Competent groups of engineers have already established the actual feasibility of and economic justification for each of the main plans thus far advocated; and it is reasonable to expect that the most desirable elements of both will be adopted.

A quotation from pages 47 and 48 of Bulletin No. 4 of the California Department of Public Works, entitled "Water Resources of California," which presents the comprehensive plan for water utilization as of 1923, contains much of value today. This quotation is as follows: "In the comprehensive plan, the excess waters of the Sacramento drainage basin would be collected in the main river channels and, by means of a dam across Carquinez Straits below the mouth of both the Sacramento and San Joaquin rivers, this water would be diverted into the lower San Joaquin River from which the grand canal would take its water. Thus the cost of conduit would be obviated for the full length of the Sacramento Valley. The grand canal would follow the smooth valley floor and its excavation would be the cheapest type of earth work....

"The dam across Carquinez Straits would have many other advantages in addition to diverting the Sacramento waters into the lower San Joaquin River. During seasons of small stream flow, there is a tendency for the salt water of San Francisco Bay to work up into the network of channels that divide the rich delta lands at the mouth of the two rivers into many islands. The dam below the mouth of these two rivers would prevent any damage to these fertile soils that might result from such occurrences. Further, this dam would maintain Suisun Bay in fresh water and make it possible to profitably reclaim all the tidal flats along its margin, and bring unlimited quantities of fresh water to the manufacturing centers arising along the bay shore.... This dam would be of added value in creating a large fresh water reservoir in Suisun Bay and the delta regions that would have a storage capacity of 500,000 acre-feet between the present levels of high and low tide.... Thus water might be brought close into the bay region without cost of conduit from the distant sources...."

Even though some details may require considerable modification and some elements of the plan may have to yield priority to such elements of the alternate plan as headwaters storage and gravity distribution wherever practicable, there are abundant and conclusive examples which controvert many of the claims of those opposing the idea of such a barrier. It has been suggested that unavoidable leakage around the lock gates might, under certain conditions, make it impossible to prevent the invasion of salt water and might even result in a condition worse than that first existing. If that suggestion should prove to be well founded, it might lead the way to revision of our present practices in regard to ventilation. To avoid the sharp drafts of cold air that persistently enter a room around the door and window casings, why not remove the doors and windows, and perhaps the intervening walls? Seriously, I do not believe that anyone would expect salinity conditions to be aggravated by construction of a barrier with locks.

C. S. JARVIS, M. Am. Soc. C.E.
Senior Hydraulic Engineer, U. S. Geological Survey

Washington, D.C.
March 25, 1936

Engineering References in Kipling

TO THE EDITOR: Rudyard Kipling, who so recently died, touched life in many points, among them that of engineering. C. S. Jeffrey, writer of an article, "The Poet and the Engineer," in the November 1935 issue of *The Journal of the Institution of Engineers,* Australia, says; "When Rudyard Kipling wrote 'M'Andrews Hymn' he should have been elected an honorary member of every English-speaking institution in the world." This is exaggeration but in the poem is the wish,

> "Lord, send a man like Robbie Burns to sing the
> song of steam."

The Australian writer continues, "To quote all Kipling's references to engineers, from the discovery of the first engineer in 'Sappers' to 'Captain Purnell' in 'The Night Mail,' would require a small anthology. One of the finest of these references is 'The Secret of the Machines.' "

The first verse of "The Sappers" from *Barrack Room Ballads* will be quoted:

> "When the Waters were dried an' the Earth did appear,
> ('It's all one,' says the Sapper)
> The Lord He created the Engineer,
> Her Majesty's Royal Engineer
> With the rank and pay of a Sapper!"

Sappers and miners are defined in the dictionary as the noncommissioned officers and men of the Royal Engineers.

Four lines of "The Secret of the Machines" reads:

> "But remember, please, the Law by which we live,
> We are not built to comprehend a lie,
> We can neither love nor pity nor forgive,
> If you make a slip in handling us you die."

However, in his prose also Kipling appreciates the engineer. A rare pleasure awaits him who has not read *The Day's Work.* Four stories of special interest to the engineer are "The Bridge Builders"; "The Ship that Found Herself"; "An Error in the Fourth Dimension"; and "Bread Upon the Waters."

Only the second of these stories will be quoted. The Scotch captain in showing the owner's daughter around the new and untried vessel remarks, "For a ship, ye'll obsairve, Miss Frazier, is in no sense a reegid body closed at both ends. She's a highly complex structure i' various an' conflictin' strains, wi' tissues that must gi' and tak' accordin' to her personal modulees of elasteecity." The characteristics ascribed to the different parts of the ship and the conversations they hold with each other are significant. "Cast iron, as a rule, says very little; but mild steel plates and wrought iron and ribs and beams that have been much bent and welded and riveted, talk continuously. . . ." "Stringers always consider themselves most important because they are so long. . . ." " 'That's all there is to it,' seethed the white water roaring through the scuppers. 'There's no animus in our proceedings. We're only meteorological corollaries.' "

ROBINS FLEMING

New York, N.Y.
March 28, 1936

Federal Classification and Industry

TO THE EDITOR: I should like to comment on the interesting article entitled, "Classification and Compensation of Federal Engineering Positions," by John C. Hoyt, M. Am. Soc. C.E., in the March issue.

The basic concept of present-day classification in the public service rests upon the premises of equal pay for equal work. The federal classification of jobs, which is based upon actual duties and responsibilities, was set up by law in 1923 to correct the chaos in government employment policies which came to a maximum after the World War.

The government buys the employees' work and expects to get full value for its money. Likewise, the employee is interested in an adequate salary and the same salary as others in similar work. There must be a salary for the type of service rendered sufficient to induce the worker to enter the field in question. There must also be a range for standards of quality, service, and opportunity for assignments to higher levels, so that the employee may change his position by new assignments, growth in additional duties, or the reverse. A knowledge of these facts is essential to the efficient working of any personnel, whether publicly or privately managed.

Where properly applied, classification is an active, motivating system, permitting constant change for the employee, as his work, responsibilities, and capabilities change. Essentially, classification serves to disclose this information, to minimize misunderstandings and differences, to maintain uniformity and equity of treatment of like work, to establish and make public qualification requirements so as to standardize examinations, and to act as a managerial aid to the creation of a fixed compensation plan and the preparation of budget estimates.

Modern public service, as well as modern private industry, has developed a high degree of occupational specialization and division of labor. In the lower levels of each job there is a concept of duty which limits activity, but this gives way to a concept of responsibility and expert service in the higher levels. For each grade level a minimum and a maximum wage become necessities, with an intervening range for each job. It is impractical to presume that this system can be completely transposed to industry, but the principles can apply and be modified to meet the local demands.

Industry has been slow to coordinate job analysis with a compensation plan. Generally, it has served in all but the larger units as a recruiting and appointment adjunct for the personnel office, more from the standpoint of fitting the right man to the right job than from that of equalizing salaries. Industry appears to be interested in classification schemes, but it is not willing to accept a rigid system and remain within its bounds, nor is it willing to publicize salary rates. Where the worker is not aware of the advantages of classification nor of the consequent avenues of promotion or change, the system does not operate fully.

Classification of positions modeled after the federal plan appears to be adaptable, with modifications, to all public enterprises where organization is necessary and where public funds must be conserved in order to secure the best available help at an equitable pay. Industrial management must go still further and unify its levels of work, coordinate the pay scales, and recognize the values of some sort of review, adjustment, or classification service, if the other studies and activities are to be worth while. Standardization of job classification, adjusted to an adequate salary level in large industrial concerns, will increase efficiency, develop more faithful and continuous service, and open up avenues of advancement and promotion in service that cannot help but improve the service which adopts it.

W. W. Stockberger
Director of Personnel, U. S. Department of Agriculture

Washington, D.C.
March 26, 1936

Limitations of Federal Classification

Dear Sir: The article on "Classification and Compensation of Federal Engineering Positions" by John C. Hoyt, M. Am. Soc. C.E., in the March issue, interests me not only as a member of the Society's Committee on Salaries, but also from the background of my personal experience during the years 1923–1924, as head classifier of the federal field services. This work involved the writing of several hundred classes of positions and a statistical study of wages and salaries paid to comparable positions in private employment.

As a result of this experience and subsequent knowledge of and contact with governmental and industrial personnel administration, it is my opinion that the federal classification system per se cannot be used in state and municipal services and for private employment. The conditions and requirements of these various services are so variable that no one system can be utilized without finding many gaps, misfits, and dislocations.

The experience of the former personnel Classification Board and the present U. S. Civil Service Commission indicates that the present federal classification system involves constant difficulty in allocation of classes of positions to grades, which are so numerous that the "shading" often makes it difficult to secure proper and accurate allocation of classes of positions to grades. The experience of the federal agencies leads them to believe that a better system would involve the use of fewer grades.

It is relatively easy to prepare uniform class specifications for many of the lower classes of engineering positions. But in the upper branches of the profession, the job content varies and it becomes increasingly difficult to establish such specifications for the same classes of positions in different locations, organizations, working and other conditions.

The experience of classification agencies indicates the advantages, wherever practicable, of a simple "straight line" classification system without grades. The adaptation and utilization of one classification system to all parts of the country and to a wide range of organizations from the smallest to the largest implies obvious difficulties in the allocation of classes of positions involving the same general titles and apparent duties and responsibilities. For example, consider the position of chief engineer. In the smaller states and private organizations the administrative responsibilities involved would be relatively limited and unimportant as compared with those of the same position in the largest states and private organizations. Obviously, it would be impossible and unjustifiable to allocate the two classes to the same level. Similarly, of course, the compensation would be materially different. This situation has arisen in connection with the use of the federal classification system, but has been arbitrarily taken care of by the classification agencies, which have authority to make the allocations in cooperation with the chief adminstrative officers.

In my opinion the Committee on Salaries and the Society cannot adopt per se the federal classification system and expect to apply it to engineering employment in state, municipal, and private services. I do recommend, however, that the Committee make a further and careful study of this system, its operation and results, with a view to utilizing such principles and elements as may be practicable in preparing a future policy and plan for classifying engineering positions.

A. B. McDaniel, M. Am. Soc. C.E.
Director, The Research Service

Washington, D.C.
April 2, 1936

Engineering and Poetry

To the Editor: In connection with Kipling's poem appearing on the Page of Special Interest, in the March issue, I should like to call your attention to a poem reprinted in *The Times* (London) of January 28, 1836. The poem, which is called "The Roadmakers—a New Ballad for the Year 1825," reads as follows:

"Ye roadmakers of England
Who sit and plan at ease,
Ah! little do ye think upon
Our cherished lawns and trees.
Give ear unto the gentlemen,
And they will plainly show
All their cares and their fears
When a-measuring you go!

"This goodly land of freedom,
With all its bowers and halls,
Is turning fast to turnpike roads,
And prisons and canals.
The sylvan elves and fairies
Have vanished long ago,
Else what cries would arise
When a-mapping it you go.

* * *

"Now courage, all brave gentlemen,
Your honours forth advance,
And yield to ne'er a despot yet
From Scotland nor from France.
Macadam would reduce us all
To break up stones, we know;
May our stones break his bones
When a-hammering he'll go."

(New stanza, added January 24, 1836)

"But now Macadam's reign is o'er
And railways take his place,
And fourteen miles an hour and more
Is deem'd a snail's foot-pace.
Their grinding irons pierce our souls,
Their furnace makes us glow.
May Brunel fare as well
If a-tunnelling he'll go."

The addition of this last stanza just a century ago brought the poem up to date. It is interesting to note that at this time Brunel was building his tunnel under the Thames.

Joseph Warren Silliman, Assoc. M. Am. Soc. C.E.

Philadelphia, Pa.
March 30, 1936

SOCIETY AFFAIRS

Official and Semi-Official

The President's Message to Young Engineers

Emphasizing Advantages of Society Membership

THE WRITER desires to offer a few suggestions to the young men who soon will graduate from the engineering schools of the country, and especially to those who are members of the Student Chapters of the Society and who hope in the near future to begin the practice of engineering.

After securing your first position in engineering work, your future will depend largely on your abilities, activities, acquaintances, and opportunities. Fair ability, studious application, and hard work are the personal attributes of success but you will find that the doors of opportunity are largely made accessible through broad acquaintanceship among engineers. To most young engineers, the best means of acquaintanceship as well as professional improvement come through active membership in the technical societies composed of those men who are interested in the line of work in which the young engineer is engaged.

You should as early as practicable join the national engineering society which represents your specialty, and also the local section of the same that is nearest to your own location. Much of the benefit of membership in a technical society is gained through attendance at the meetings and, as early as practicable, in taking part in the discussions. The printed papers and discussions offer you a splendid opportunity to keep up with the technical advancement of your profession, which is one of the important factors in professional success.

The writer looks back on the more than fifty years that have elapsed since his own graduation and wishes to assure all young engineers of the great benefits which he received through his membership in various engineering societies, and especially from his membership in the American Society of Civil Engineers.

You young engineers who have been members of a Student Chapter can join the Society with your first year's dues remitted if your applications are received within two months after graduation.

The engineering profession owes its present position in no small way to the work of these societies done in the past. By joining the national societies and taking an active part in their work, you will do your part in aiding these societies to further advance the profession.

You young graduates are the men who are to take up the work which many of the older members must soon lay down, and there is great need that you should be well trained and thoroughly informed, and that you should be men of courage, energy, and high ideals.

In the judgment of the writer, the young engineer who fails to connect himself as early as possible with the local and national engineering societies which represent his individual line of work misses opportunities to orient himself and his professional work, to increase his knowledge, to broaden his acquaintance, and to increase his availability for professional advancement that can be supplied in no other way. Most opportunities for advancement come through the engineer's acquaintance with other engineers who know and appreciate his energy, knowledge, and abilities; and every young engineer should take advantage of membership in these engineering societies if he desires the greatest opportunities for engineering success.

DANIEL W. MEAD, *President,*
American Society of Civil Engineers

Madison, Wis.
April 1936

Social Progress and Industrial Research

Excerpts from an Address by Charles F. Kettering

ON FEBRUARY 25, 1936, the Washington Award for 1936 was presented to Charles F. Kettering "for his high achievements in guiding industrial research toward the greater comfort, happiness, and safety of mankind in the home and on the highway." Upon presentation of the award, announcement of which was made in the February issue of CIVIL ENGINEERING, Mr. Kettering delivered a very interesting address on the relationship of engineering research and social progress. Some excerpts from this address follow:

"I was talking to a young man one day and he said, 'I think there ought to be a halt called on scientific and engineering developments, because we have gone faster than we are able to socially absorb'....

"I asked him if he had any trouble absorbing the improvements that have been made in medicine, whether he felt that he had socially outrun the improved ability to remove an appendix; how much development he had to do socially, mentally, or otherwise to get the benefits of the best surgeons in the world? So I think it is only foolish for us to say that we are not able to absorb socially the developments that we have. The thing that we need to do is to work out the economics of those things so they can flow infinitely more freely than they do. In other words, we have many things developed today which should have a wider distribution....

"I do not feel that anybody should be discouraged, and never have, because out of all of these experiences it is impossible for us, even those in industry, to project industrial developments a few years ahead. I have been associated with the motor car industry for many years and yet I have never seen even the best forecaster...tell what was two years ahead in that highly organized line. What can we do that we haven't done? People say, 'What are the next great industries?' . . .

"The engineer must do one great thing. He must teach his financial supporters how to raise industrial children. Remember that a great many of our adventures came as just the natural flux of picking up this thing or that thing and turning it into a useful tool. But as time has gone on, the technicalities of this development work have become greater. Today, the individual does not count for very much—only in so far as that individual can analyze what the controlling problem is and bring together such groups of technicians as are necessary to solve the particular parts. We are in a transition from the individual as a producer of new industries, to the group. We don't know how to do group work very well....

"We must treat research, therefore, as an insurance policy. Whatever we pay for that we must think of on the actuarial basis; over a given period of time and over a fairly large number of projects, enough good will comes out of it to make it worth while. We have said that the depression has cost us an enormous amount of money. Nobody knows how much—billions of dollars we are told, and yet a billion dollars a year would keep five or six hundred research laboratories going full time, provided you could get the men. Of course, we haven't yet enough trained men to run that many laboratories, but if we had, and had them running for three or four years, the banks would have no money and there would be no unemployment. We would have 'help wanted' on every door of every factory in America. That price would be infinitely less to pay for this industrial development than trying to artificially

SIXTY-SIXTH ANNUAL CONVENTION OF THE SOCIETY, to be held July 15–17, 1936, in Portland, Ore.

stimulate one in which the principle, the fundamental principle, is not fully recognized....

"So I am for more experimental work in science. I am for bringing out or trying to convert, if you want to think of it [that way], some of the intangibles of our modern science to see if we can't spin them into the threads that the engineer can use, and weave them into our everyday work....

"What are some of the things we would like to have? Why can't we have them? Research is not a thing that goes with a laboratory. It is purely a principle and anybody can apply it. It is simply to try to find out if you are satisfied with what you have, where you are, and what you are doing. Write down ten things that you don't like about your business, about yourself, or the things you are doing or working with as your problems. You may not be able to solve number one, because it may be a very difficult thing, but you will be able to pick out one of them that you can solve, just as you put a word in a cross-word puzzle. Finally, after a period of time you will be surprised to find how these things break down if you persistently work at them....

"I think the next ten years is going to see a complete renaissance in engineering and scientific development. It is all ahead of us. In every period in time somebody has said, 'I don't see what new there is to be done.' Go out and look. Take any book that gives you the history of industry, and tear out half of it. Read up to that, and some will say the world is finished. But if we can remove the bugaboo of 'the world is finished,' and put in its place, 'the world is begun,' we will have a marvelous place in which to live and a marvelous future ahead of us."

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Columbus Regional Meeting to Feature Sewage Treatment

On May 15 and 16, 1936, a regional meeting of Local Sections will be held at Columbus, the capital city of Ohio. Nine papers will be presented on various problems in Columbus and nearby communities, with emphasis on sewage treatment and water supply. All Society organizations in District 9, including Student Chapters as well as Local Sections, have been invited to cooperate.

The meeting will come to order on Friday morning, May 15, at 11:00 a.m. After an address of welcome by Mayor Gessaman of Columbus, an interesting group of technical papers will be presented. The papers will deal with such subjects as the state and local PWA program; the Columbus relief, sanitary, storm, and intercepting sewers and regulator chambers; design and construction of the new city sewage treatment works; construction of water works and sewers for various Ohio villages; silting of the city water works and reservoirs; the Dublin Bridge and highway grade separation work; modern refuse incineration for Columbus; and the WPA traffic survey for that city. An informal stag banquet, entertainment, and smoker is scheduled for 6:30 p.m. Later in the evening Willard T. Chevalier, M. Am. Soc. C.E., Vice-President of the McGraw-Hill Publishing Company, Inc., will speak on the subject, "The Engineer's Relation to Current Economic Trends."

Saturday will be devoted to an all-day inspection trip to the new Columbus sewage treatment works and the new refuse incinerators; to Main Street Bridge, now under construction; Dublin Bridge; O'Shaughnessy Dam; water works reservoirs; and various other points of interest. The inspection trip is free of charge.

Meeting headquarters will be at the Deshler-Wallick Hotel. The meeting is not limited to any particular territory or to members of the Society. All interested engineers are welcome to attend. Accommodations in Columbus are ample, and rates for rooms and meals are reasonable.

Engineering Foundation Adopts New Platform

The Engineering Foundation was established in 1914 by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers "for the furtherance of research in science and engineering or for the advancement in any other manner of the profession of engineering and the good of mankind."

A brief platform was adopted by the Board of the Engineering Foundation on June 14, 1935, approved by its Board of Trustees on June 27, 1935, and approved by the Founder Societies in the fall of 1935. It is believed that this document is of sufficient interest to merit publication in full, as follows:

"Preamble

"The Engineering Foundation Board has contemplated its prospects for usefulness to the Profession of Engineering and to mankind, together with its probable resources of men and money. Guided by the experience of twenty years, characterized by profound changes in science, engineering, economics, industry, and political organization; assisted by many expressed opinions of members of its Founder Societies and friends; and encouraged by commendations and additional gifts from its Founder and other persons, the Foundation Board, without limiting the discretionary power bestowed by the Founder and the Founder Societies through its broad charter, expresses its general plan and policy for the near future in the following platform, which supersedes the platform of 1925.

"General Plan and Policy

"1. The Engineering Foundation recognizes the responsibility of leadership placed upon it for attaining the objectives set forth in the deed of gift.

"2. The Foundation will concern itself with human as well as technical aspects of engineering problems of wide interest. Activities which will have as their main objectives 'the advancement of the profession of engineering,' whether by research or other means, will be given preference.

"3. The Foundation will initiate new projects or will select from time to time projects presented to it which are deemed most likely to attain its objectives.

"4. In examination of proposals and in development of those selected, the Foundation will seek the collaboration of members or committees of its Founder Societies especially conversant with the subject under consideration. It will also seek other counsel as needs arise.

"5. It will assist in developing selected proposals into organized projects, and will choose a competent agency for the conduct of each project, when in approved form.

"6. It will assist approved projects, according to the needs of each, by grants of money, by solicitation of contributions of money, services and materials, and in other ways.

"7. Responsibility for development and prosecution of each project shall rest upon the chosen agency, which agency shall have the largest practicable measure of freedom in carrying out the project.

"8. The Foundation will require periodically an accounting for resources supplied for each project and acceptable reports of results.

"9. Proposals recommended by its Founder Societies and of broad interest to the Profession will be given preference.

"10. The Foundation will endeavor within its sphere of influence to prevent conflict of research activities and such duplication as would be wasteful."

Suggestions for Local Section Year Books

Data on Cost and Content Furnished by Section Secretaries in Reply to Questionnaires

"Do you personally believe that your Local Section would be benefited by publication of a year book?"

This question was recently asked the secretary of each Local Section, and enough affirmative replies were received to justify a compilation of data on the costs and contents of the ten year books most recently published. The results should be useful, however, not only to Sections making their first attempt along these lines, but to "old hands at the game" as well.

To officers and committee members a Section year book, or some sort of substitute, is obviously indispensable. And to the Section as a whole a year book, if thoughtfully planned, can be made almost equally important, for it stands as a concrete symbol of activity to every member. It contains a record of things done and a program of things that are to be done, and is a year-round reminder that the Section is a businesslike and useful organization. Finally, one part at least of the year book is of direct value to every member—the convenient listing of his fellow engineers in the area.

YEAR BOOK
CENTRAL OHIO SECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS
YEAR BOOK
YEAR BOOK
YEAR BOOK
VIRGINIA SECTION
American Society of Civil Engineers
LIST OF MEMBERS
FOR
1935

SOME EXAMPLES OF LOCAL SECTION YEAR BOOKS

The need for a year book is definitely not limited to the larger Sections. One group with but 28 members found it desirable to issue last year a "Record of Activities" and a membership list; and in all, four Sections with less than 90 members each put out year books in 1935. In the years before the depression the number of small Sections with year books was about twice as great.

So much for advantages. On the other side is the question of cost. Granted that a publication is desirable, is it within reach?

An attractive 16-page book suitable for a Section with say 150 members, probably can be printed at a total cost of about \$60—an expenditure by the Section of 40 cents for each member. The most expensive of the books published last year involved an investment by the Section of only 45 cents per member, and the average was 37 cents. Unit costs for printing are likely to be misleading, but it may be stated that the average cost per page for the six printed books for which costs are available was \$3.76. For a mimeograph job, the cost is reported to be in the neighborhood of \$1 a page. It should be borne in mind that the cost of printing may be somewhat higher the first year than in succeeding years, for if a book is carefully planned it will be possible to hold a large part of the type for re-use in later issues.

Although the photo-offset process was not used for any of the year books now at hand, its possibilities might well be examined. It permits the reproduction of snapshots, newspaper clippings, line drawings, and many other special types of copy without extra cost. Moreover, it gives a neater appearance to typewritten copy than can be obtained with even the best mimeograph job, and the fact that each sheet can be printed on both sides means a saving in the cost of paper. A photo-offset company in New York recently quoted a price of \$1.70 per $8^1/_2$ by 11-in. page for 100 copies.

What features should a year book contain? Obviously, the answer depends on the particular requirements of the Local Section in question—and to a somewhat lesser extent on the amount of money at its disposal. However, in almost every one of the ten Section year books now current there was found some feature of value that did not appear in any of the others. Hence it seems desirable to present a check list that is essentially a composite table of contents of these ten volumes, together with such remarks as seem pertinent. Asterisks have been placed before those subjects that appear to be more or less supplementary, and that would perhaps be the first to be considered for omission; nevertheless, it is believed that all the subjects are worthy of consideration. The list follows:

A. General introductory statement
    1. General aims and activities of Section
    2. Time and place of meetings (general)
    3. Dues
    4. Other general remarks
B. List of Section officers
C. Committees
    1. Name of committee
    2. Statement of its general purposes
    *3. Review of previous year's work
    4. Specific projects in view for coming year (if available)
    5. List of members
D. Prizes or scholarships to student members (if given)
    1. Statement of requirements and method of award
    2. List of recipients
E. Treasurer's report
    1. Fairly detailed statement of receipts and disbursements
    2. Balance sheet
    3. Budget for coming year
*F. List of meetings and special functions of previous year
    1. Date, place, nature of event (meeting, inspection trip, etc.), and attendance
    2. Speaker and subject; discussers (or project visited)
    3. Special entertainment
*G. Detailed report of Section activities and history

Item G may take the form of a secretary's report, or an address by the outgoing or incoming president. If the Local Section publishes monthly news letters, they are perhaps the more logical place for such addresses. Furthermore, if Item C is worked out in detail, Item G may be entirely unnecessary.

H. Program for coming year (to whatever extent it has been worked out)

Item H may be arranged like Item F, or combined with it, but its advertising value warrants its being given the fullest treatment possible.

I. Separate section for the local association of Juniors (if there is one)

Item I can be modeled on Items A to H.

*J. Separate section for the Student Chapters (if any) sponsored by the Local Section

Item J can be modeled on Items A to H.

K. Membership lists
    1. Alphabetical, giving
        (a) Business affiliation (especially important to the officers in selecting committees)
        (b) Business address
        (c) Home address
        *(d) Telephone number

2. Geographical (usually by towns, based on mailing addresses)

This item is valuable for Sections extending over any considerable area.

3. "In Memoriam" (a list of members deceased during the preceding year)

L. Miscellaneous information

1. List of past officers of Section
2. List of Vice-Presidents and Directors of the Society for the Zone and District in which the Section is located

*3. List of members of the Section serving on committees of the Society

*4. List of other Local Sections in the vicinity, with addresses of the secretaries (possibly also general time and place of meeting)

*5. List of near-by Student Chapters (possibly also general time and place of meeting)

*6. Analysis of Section membership
   (*a*) Yearly membership totals since organization
   (*b*) Number of members in each specialized branch of the profession

M. Papers by Section members

1. List of papers contributed by members of the Section during the preceding year to CIVIL ENGINEERING, PROCEEDINGS, TRANSACTIONS, or other technical publications

This information may be obtained by the use of indexes in the case of Society publications, or in special cases by writing to Headquarters.

*2. List of papers presented at all past meetings of the Section

This item is probably desirable only in case the Section maintains a file of these or publishes them elsewhere. Even then, in the interest of space economy, it might be desirable to omit all but the last two or three years, and publish a note referring interested persons to the secretary of the Section for a complete list.

*3. Brief but readable abstracts (say 500 to 1,000 words each) of papers presented at meetings of the Section

This material might better be published in the monthly Section bulletin, if such a periodical is available.

N. Constitution and by-laws of the Section

O. Code of ethics of the Society

There remains the question of size. A 16-page printed book has previously been mentioned as satisfactory for a Section of about 150 members; this proportion of 1 page to every 10 members is the average for the 7 current printed books, and is a good figure on which to base a preliminary estimate for any Section with 100 or more members. Individual books, however, varied between 1 page for each 6 members and 1 page for each 15 members. The page size is usually 6 by 9 in.

It should be pointed out that with careful planning a printed page can be made to carry a great deal of information without undue crowding. For example, while the membership list in one year book required a page for each 15 names, another book using the same size of type but a different arrangement, carried more than 30 names to the page and was equally legible. Space saved in this way permits either the inclusion of additional features or a reduction in the total cost of the book, and either possibility is well worth consideration.

For Sections of less than about 100 members, mimeographed or photo-offset year books may be preferred. One $8^1/_2$ by 11-in. page, or somewhat more, should be allowed for every 4 members.

The information in this article was compiled from data furnished in November 1935 by the secretaries of the following Local Sections: Central Ohio, Colorado, Illinois, Los Angeles, Metropolitan, Panama, Philadelphia, San Francisco, Texas, and Virginia. Their cooperation is sincerely appreciated. In the photograph, the year books of the Central Ohio, Illinois, Metropolitan, Philadelphia, San Francisco, and Virginia Sections are shown.

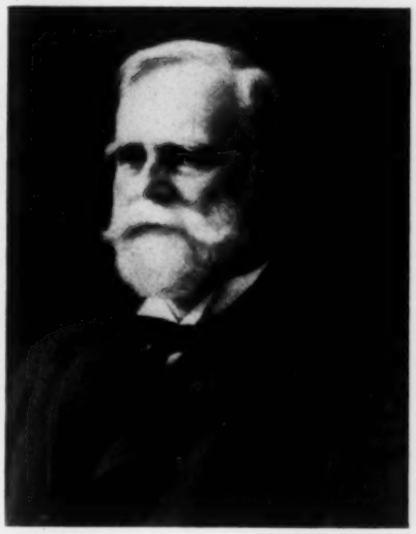
Spring Meeting of Society in Progress at Hot Springs

AS THIS ISSUE of CIVIL ENGINEERING goes to press, the Society's Spring Meeting, held in Hot Springs, Ark., April 22 to 25, 1936, has gotten off to an auspicious start. The well-rounded program includes 13 technical papers on various phases of the engineering problems and industrial resources of the lower Mississippi basin A paper on the construction features of the Fort Peck project in Montana is also scheduled.

The facilities of the July number will be entirely taken up with abstracts of these addresses, which will thus be brought to the attention of every member in as complete a form as space will permit. As the Spring Meeting takes place so late in April, it will unfortunately not be possible to publish this material in the June number, now in preparation.

Onward Bates, 1850–1936

ONWARD BATES, Past-President and Honorary Member of the Society, died at the age of 86 at his winter home in Augusta, Ga., on April 4, 1936. His death ended a career begun before the close of the Civil War. In the spring of 1865, when but 15 years of age, Mr. Bates entered into a "gentlemen's agreement" with the proprietor of the Fulton Iron Works in St. Louis, Mo.—a sort of informal apprenticeship during which he was to be trained as a civil engineer. Three years later he was released to serve under C. Shaler Smith, M. Am. Soc. C.E., on the construction of the bridge over the Missouri River at St. Charles.



ONWARD BATES

In 1878 Colonel Smith and William Sellers, president of the Edge Moor Iron Company of Wilmington, Del., formed a company for the purpose of introducing American bridges in Australia. Mr. Bates, who in the meantime had studied for two years at the Rensselaer Polytechnic Institute and worked as inspector and engineer on a series of important bridges, was selected as their Australian representative. His achievements in the next three years justified their selection. Overcoming the natural prejudice of the colonists in favor of the English riveted construction, he succeeded in securing contracts for three major bridges of the American pin-connected type. All were successfully completed.

After the affairs of "the Australian venture" were wound up, Mr. Bates was associated in other projects with both Colonel Smith and the Edge Moor Iron Company, and later became president of the Pittsburgh Bridge Company. In 1888 he returned to the Chicago, Milwaukee and St. Paul Railway, with which he remained for 13 years. For more than half of this period he served as engineer of bridges and buildings, covering some 6,000 miles of line. In 1901 he again took up private practice.

After his nominal retirement he was called upon for extensive and conspicuous services as an engineering arbitrator. In seven of the eight notable cases in which he acted as arbitrator for railroads he was the choice of all parties; in four cases he was the sole arbitrator.

Mr. Bates was a Vice-President of the Society in 1906–1907, became its President in 1909, and was elected to honorary membership in 1923. His other awards included honorary membership in the Western Society of Engineers and the Chanute medal of the same organization, given for his paper on "Engineering Arbitration." He held an honorary degree of doctor of engineering conferred by Rensselaer Polytechnic Institute in 1918, and an honorary LL.D. from the University of Missouri in 1924. He was a member of the Institution of Civil Engineers, the American Railway Engineering Association, the Franklin Institute, the Royal Society of Arts, and other societies.

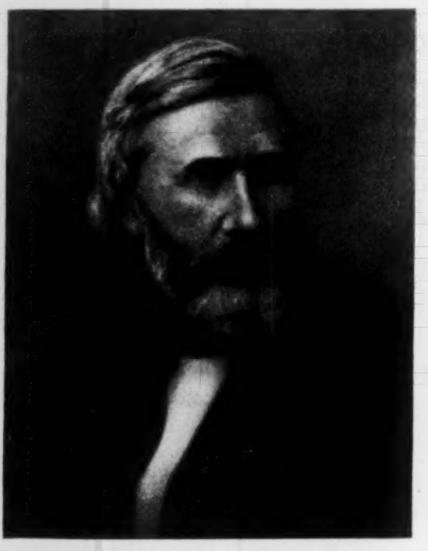
Early Presidents of the Society

This is the second of a series of brief biographies of early leaders of the Society. It is again urged that any one acquainted with personal incidents in the lives of these men, or having photographs of engineering works with which they were connected, communicate the information to Society Headquarters. The next three installments will be concerned with William Jarvis McAlpine, Alfred Wingate Craven, and Horatio Allen.

II. JAMES PUGH KIRKWOOD, 1807–1877

President of the Society, 1867–1868

IT IS the privilege of comparatively few engineers to be pioneers in any branch of their profession; and rare indeed is the privilege of pioneering in two branches. Yet such was the fortune of James Pugh Kirkwood, who devoted the first half of his career to the railroads in the days of their infancy, and turned in middle life to the problems of municipal water supply, which at that time were just beginning to attract serious attention.



JAMES PUGH KIRKWOOD, SECOND PRESIDENT OF THE SOCIETY

Kirkwood was born in Edinburgh, Scotland, in 1807. At the age of 14 he was apprenticed to a land surveyor—a fortunate connection, for the surveyor's office soon developed into a civil engineering firm, and Kirkwood remained with it for 11 years. Then he set up in business for himself in Glasgow.

But the urge to pioneer was not to be resisted, and within a few months he sailed for America. He found his first employment on the Norwich and Worcester line in 1832, and within 12 years had served as resident engineer or engineer of construction on a half-dozen roads in New England.

About 1845 there came a brief interlude in Florida—made necessary by the state of his health, which remained poor for the remainder of his life. He put his southern sojourn to advantage, designing and constructing (until the appropriations were suspended) the large naval depot projected by the government at Pensacola.

In 1848 the New York and Erie Railroad was striving feverishly to finish its line to Corning, N.Y. But the Randolph Ridge, just west of Deposit, was defying its efforts. Three contractors had successively tried and failed to bridge the valley of Starucca Creek, an abrupt depression a quarter of a mile wide and a hundred feet below the lowest elevation that could be found for the road bed in the surrounding hills. In despair the company appealed to one of its leading contractors. "Who can build that viaduct?" he was asked.

"I know of no one who can do it," he replied, "unless it is Kirkwood."

E. H. Mott tells the story in *Between the Ocean and the Lakes: The Story of Erie.*

"The matter was presented to Kirkwood. He visited the spot, investigated the facilities for getting stone and material, and reported.

" 'I can build that viaduct in time,' he said, 'provided you don't care how much it may cost.'

"He was told to go to work at it regardless of cost. The quarries from which the stone was obtained were three miles up the Starucca Creek. Kirkwood put down a railroad track on each side of the creek and brought the stone in on cars. Every available man in the vicinity was employed. Operations were pushed night and day, and with such system that the viaduct was ready for use long before it was required." At that time "it was the greatest work of railroad bridge masonry in the United States"—1,200 ft long, 110 ft high, having 18 arches with spans of 50 ft each. "It was wisely constructed for a double track, and was made 30 ft wide on top. The cost was $320,000, the most expensive railroad bridge in the world at that time." This engineering feat gave Kirkwood such prestige with the company that he was selected as general superintendent of the road.

But the scene of truly "pioneer" railroading was rapidly shifting westward; by 1850 plans were under way for the construction of the first railroad west of the Mississippi. This was the Pacific Railroad—later the Missouri Pacific—with its eastern terminus at St. Louis. Kirkwood was selected as its chief engineer, and proceeded to make an exhaustive study of possible routes across the state. Apparently he felt that an estimate of traffic available on the various routes was somewhat out of the province of the engineer—but once the subject had been introduced, with a word of apology he attacked it with thoroughness, and the greater part of his report is taken up with it. He carefully examined each possible source of freight and passenger revenue, and recommended the route along the Missouri River, despite the very definite competition that would be offered by the steamboats.

An important question was the proper gage for the new track. Kirkwood recommended a 5-ft 6-in. gage, and prepared a thorough report setting forth its advantages. The "narrow" gage (the present standard), he said, had been adopted in England at a time when horsepower was used on the railroads, and was satisfactory for the freight and light passenger business "which the indifferent accommodations of that day created." Later roads had been modeled on the early ones, and the network had grown so rapidly that by the time a different gage began seriously to be thought of a change was impossible. The same was true, he pointed out, in New England—but Missouri was virgin territory.

"The transfer of cars and engines built in another state need hardly be considered," he wrote, "inasmuch as all these will eventually be built in St. Louis. . . . Were the Mississippi River bridged, it would doubtless be convenient to be able to transfer cars from one road to another."

Kirkwood's chief arguments in favor of the wider gage were that it admitted of a better proportioned boiler and therefore would make the engines more efficient; that it permitted larger driving wheels, thereby reducing the velocity of the pistons and the gearing, and hence the general wear and tear on the engine; that the larger driving wheels would permit greater speeds; that the space allotted to each passenger would be less confined and would permit "that change of position so essential to comfort on a long journey"; and that it would reduce the required number of freight cars. Kirkwood closed his report with a list of locomotive builders and engineers whom he had consulted in regard to the matter, and the consensus of opinion was overwhelmingly in favor of the wider gage. His recommendation was adopted; and in 1853 the state legislature of Missouri approved a statute setting the gage for all railroads in the state at 5 ft 6 in.

After five years with the Pacific, Kirkwood returned to New York and carried out successfully an especially ticklish job in connection with the Croton water supply of New York City. Without interrupting the supply of water, he lowered the great water main in Eighth Avenue and moved it horizontally into a rock cut.

The neighboring Borough of Brooklyn then engaged him as chief engineer of the Nassau Water Works, and he remained in that capacity until the plant was finished four years later. In this work he was called upon to solve many problems that now fall within the province of the mechanical engineer—for example, the design and testing of the pumping engines. He is credited with several valuable contributions in this field.

While engaged in this work the question of coating cast-iron pipes came up. Working at a time to which one is now likely to refer casually as "before any modern developments took place," it is surprising with what thoroughness he sought out existing information on the subject. No expensive experiments for him, that might duplicate the work of others. He circularized the technical periodicals of Europe, and succeeded in obtaining 14 replies with as many different schemes for the protection of pipe which had already been put into use on the continent. Among them was the method of coating the pipe with coal tar. Although the research was carried on for Brooklyn, it appears that Boston, in 1858, was the first American city to make use of the process.

In 1864 Kirkwood was retained by the City of Cincinnati to make an extensive study on the best means of providing the town with an adequate water supply. One paragraph of his report throws considerable light on the status of water supply engineering at that time:

"My stay here has enabled me to watch the state of the water as received in the dwelling houses. . . . In April and May, when the falls of rain were frequent and heavy, the water was so turbid as to be disagreeable to wash in; no one could be expected to bathe in such water as a measure of cleanliness, though one might possibly do so for the refreshment which its coolness might produce. To use such water freely may be said to be unnatural."

What was true of Cincinnati was equally true of many another large town that drew its supply from surface waters. Kirkwood knew that slow sand filtration was practiced in some 20 cities of Europe, and earnestly advocated its adoption in the United States. A few months later he presented the case for filtration so well to the water commissioners of St. Louis that they sent him to Europe to gather the facts at first hand.

His instructions were delivered in December of 1865; by the fall of the following year he had returned with his complete report, which became a classic in the field of water works engineering, and was used as a text by water supply engineers for many years ("Report on the Filtration of River Waters for the Supply of Cities as Practiced in Europe"). Included in it were drawings of all the foreign plants he had visited, and a general explanation of the theory and design of the slow sand filter. In addition there was a section devoted to his recommendations for the design of filters for the St. Louis supply.

Although his recommendations were not adopted by St. Louis, he was retained as consulting engineer by the city, and had complete charge of the design and construction of the city's water supply system for several years, until his return to New York in 1867. In 1872 he had the pleasure of designing and building the first municipal sand filter in the country, that at Poughkeepsie, N.Y.

His return to New York was timely for the Society. It would have been impracticable in those days to select a president from any distant part of the country, and a more able successor to Laurie would have been hard to find. During Kirkwood's administration (1867–1868) the custom of holding semi-monthly meetings was established; the Fellowship Fund was set up for the purpose of printing and disseminating papers; and the first Committee on Publications was appointed.

The last ten years of Kirkwood's life were spent in the East. At one time or another during this period the water supplies of Portland, Lowell, Fall River, Salem, Lynn, Lawrence, Poughkeepsie, Brooklyn, Hempstead, Albany, Hoboken, Weehawken, and Pittsburgh all claimed his attention, and in 1875 he made a comprehensive survey of the pollution of the rivers of Massachusetts for the board of health of that state. He was in active practice until within a few months of his death, although the ill health which had afflicted him for 30 years caused more and more frequent interruptions in his work. "It is a wonder," said one associate, "that one so reduced in strength can command the great store of facts and principles his lifetime has gathered, and so readily apply them to the matter in hand." In the latter months of 1876 the entries in his diary alternate with pitiful regularity between "Sick today," and "Worked on notes." He died on April 22, 1877.

[The courtesy of W. J. Burton, M. Am. Soc. C.E., in supplying information on Kirkwood's work with the Pacific Railroad is gratefully acknowledged.]

What's in the Year Book?

On April 15 the 1936 Year Book—480 pages of information about the Society and its members—was placed in the mails. Doubtless many a member by now will have given it a glance and filed it away with a mental note that it is a good place to look for addresses. But the Year Book is worthy of several other mental notes as well.

Are you looking for a job? Page 87 describes the employment service of which the Society is a joint manager. Do you need information on some engineering subject beyond the scope of your local library? Pages 77 and 78 of the Year Book tell of the services offered in such cases by the Engineering Societies Library in New York. Or perhaps the list of research and Technical Division committees on pages 8 to 16 will put you in touch with a member who can inform you of the latest developments along the line in which you are interested. Are you going to be in a distant town on business? There may be a Local Section of the Society there whose secretary could be of assistance; look on page 50. Or perhaps some other engineering society in that town extends privileges to members of the American Society of Civil Engineers; look on page 84. Do you want to submit a paper for Civil Engineering or Proceedings? The rules are given on page 46. Perhaps your paper is eligible for one of the numerous prizes offered by the Society. The list of prizes and requirements begins on page 63.

Before putting the Year Book back on the shelf, glance at page 478—a summary of the geographical distribution of the Society's membership. And test your knowledge of geography by trying to name the countries of the world in which there is not someone who wears the badge. For even the best geographer, the list will not be very long.

A great deal of work goes into the making of a Year Book. To bring up to date the addresses and business affiliations of 15,197 members—especially with the unusual amount of shifting that has taken place during the past year—is in itself no mean job. In addition the paragraphs describing the work of the American Engineering Council, the American Standards Association, and a dozen other organizations must be referred to the proper sources for correction and revision. In all, the preparation of the book requires the full time of two senior assistants at Headquarters for more than two months, and routine attention throughout the rest of the year. When the heaviest rush of change-of-address cards is under way, and when proofs are coming back from the printer, about ten members of the staff assist in various parts of the work.

The completed volume, it will be found, contains the answers to a large percentage of the inquiries that are addressed by members to Headquarters throughout the year.

Suggestions Requested for Preserving Data on Floods

The Committee on Flood Protection Data has been giving consideration to the practicability of bringing together collections of flood data from various sources, and to the creating of a permanent repository for such data, accessible to the engineering profession.

There is, at present, no library or designated repository devoted to flood data; a mass of published and unpublished material is scattered throughout the country. Many of the public and semi-public reports are out of print; some are in urgent need of revision. No agency appears to exist that is willing to take the responsibility of methodically filing valuable private collections of published and unpublished flood data left after the deaths of the owners, and of undertaking to make such data available for general reference. Few engineers possessed of such collections of flood data appear to be making provision for their ultimate disposal.

Yet at no time in the history of engineering has there been such demand for flood data as at present. What should be done to prevent valuable contributions from becoming lost to the profession through storage in the attic or by dumping into the ash can is, in the last analysis, the question to which this committee is seeking an answer.

There have recently been brought to the attention of the committee two cases which have done much to bring the situation clearly into focus. One ardent investigator in the field of historic floods and of flood frequency states that he has made provision, in the event of his death, for the presentation of his entire collection of flood data to the Library of Congress. It is his thought that this library is the logical repository for such collections, as it can be depended upon to properly catalog the material presented to it, and to keep it available upon demand. He feels that all engineers possessing similar collections should follow his plan. Another investigator has copyrighted his thesis—a remarkably thorough piece of work on the magnitudes and the frequencies of Cumberland River floods—and placed it on file in the library of Vanderbilt University.

These two cases indicate a divergence of opinion on the part of engineers interviewed on the subject of creating a flood data repository. This committee is not ready to submit its recommendations to the Society. It appears to be advisable first to solicit opinions from the Society's membership at large, perhaps through the medium of the columns of CIVIL ENGINEERING, and thus effect a desirable interchange of opinions in print.

For the Committee on Flood Protection Data
GERARD H. MATTHES, *Chairman*

Charles Louis Strobel, 1852–1936

CHARLES LOUIS STROBEL, Hon. M. Am. Soc. C.E., died at his home in Chicago on April 5, 1936. He was 83 years of age and had been a member of the Society for 57 years. Mr. Strobel was born in Cincinnati, Ohio, in 1852. He attended the public schools of that city until 17 years of age, and then went to Europe for his technical training. He was graduated from the Royal Institute of Technology at Stuttgart, Germany, in 1873.

CHARLES L. STROBEL

From 1874 to 1878 he was assistant engineer of the Cincinnati Southern Railway (then under construction and now a part of the Southern Railway). In this position it was his duty to analyze the competitive designs for bridges and viaducts submitted by bridge contractors on invitation of the railroad company. The structures included the Ohio River bridge at Cincinnati, with a 519-ft span, and the High Bridge (cantilever spans) over the Kentucky River. Mr. Strobel introduced in this work, probably for the first time in this country, the calculation of stresses based upon definite locomotive wheel loads, followed by uniform train loads. His scientific analyses were an important contribution to the development of bridge designing in this country.

From 1878 to 1885 he was assistant to the president and engineer of the Keystone Bridge Company in Pittsburgh, Pa., and in the following eight years he was consulting engineer and agent in Chicago of the Keystone Bridge Company as well as consulting engineer to Carnegie, Phipps and Company, Ltd., to the Chicago, Milwaukee and St. Paul Railway Company, and to others.

During this time he designed the first standard sections for I-beams and channels for Carnegie, Phipps and Company, Ltd., and proposed the rolling of Z-bars and the use of Z-bar columns for the towers of a viaduct for the Chicago, Milwaukee and St. Paul Railway, in connection with the design of the Randolph Bluffs Bridge over the Missouri river. He also took a prominent part in the development of skeleton steel structures for Chicago office buildings and designed large bridges over the Missouri, Mississippi, Ohio, and other rivers.

In 1890 Mr. Strobel designed and superintended the erection and floating into place of the 525-ft span of the Ohio River bridge below Pittsburgh, Pa., for the Ohio Connecting Railway. The height of this structure afloat was 143 ft above the surface of the water and its weight, including falsework, was 1,800 tons.

From 1893 to 1905 he engaged in independent business as a contracting engineer, the firm later being carried on as a corporation under the name of the Strobel Steel Company. In 1926 he withdrew from the contracting business, after contributing much to the development of movable bridges of the bascule and similar types.

Mr. Strobel was the author of many papers and discussions, and perhaps none of his contributions to engineering has been more important than his outstanding work as an author, compiler, and editor of *A Pocket Companion of Useful Information and Tables, Appertaining to the Use of Wrought Iron—for Engineers, Architects, and Builders.* This book was first prepared for, and published by, Carnegie Brothers and Company, Ltd., in 1881. Later editions were revised by Mr. Strobel, and the book, now known as the "Carnegie Handbook," is still based on his original and fundamental work.

Mr. Strobel served as Director of the Society in 1886, and again, to fill a vacancy, in 1894. In 1911 he was elected a Vice-President, and in 1932 he was made an Honorary Member. He was also a member of the Institution of Civil Engineers, and of the Western Society of Engineers, and belonged to the Chicago Engineers Club and the Engineers Club of New York.

Golden Anniversary Dinner Honors Three St. Louis Members

ON MARCH 23, 1936, the St. Louis Section honored Edward Flad, Charles de la Cherois Purdon, and Silas Bent Russell with a golden anniversary dinner in recognition of their fifty years of membership in the Society. An interesting feature of the program was a biographical sketch of each of the guests of honor. Other speeches emphasized the many friendships made by the three and the great public good done by their work.

Edward Flad came to civil engineering by heredity, being the son of the late Henry Flad, M. Am. Soc. C.E., who played a major part in the construction of the Eads Bridge. He was for five years assistant engineer of the St. Louis water works and later became water commissioner and a member of the St. Louis Board of Public Improvements. He has also served as a member of the Missouri Public Service Commission and the Mississippi River Commission, and during the War was a member of the Naval Consulting Board. He is the author of many professional papers on both construction and valuation subjects.

Charles de la Cherois Purdon came to this country from Ireland at the age of 18 in the hope of becoming a linen salesman but was soon attracted to railroad engineering, and before he was 35 had held important positions on railroad location and construction in Nova Scotia and the southern United States. In the following years he became successively assistant chief engineer of the St. Louis, Arkansas and Texas Railroad, bridge engineer of the Santa Fe, assistant chief engineer of the same road, chief engineer of the Frisco, and chief engineer of the St. Louis Southwestern. After sixty years of engineering experience, Mr. Purdon retired from active work in 1929.

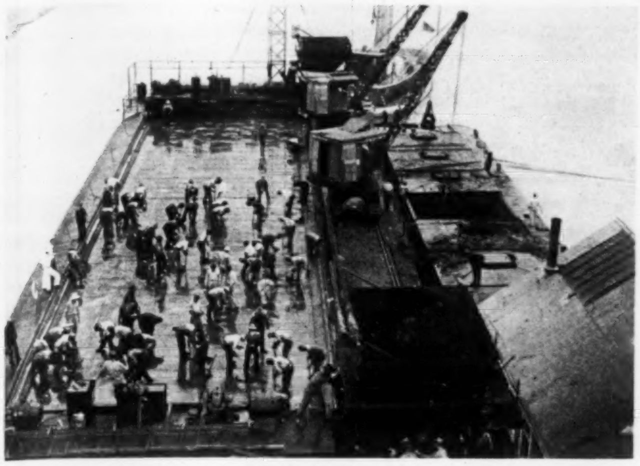
Silas Bent Russell was engaged for 35 years (1881 to 1916) in water works construction for the St. Louis Water Department. During this period he was frequently called in as consultant by other cities. After eight years of work in connection with industrial furnaces and coal gas plants, he returned to the Water Department and made valuable contributions to the plans of the new St. Louis water works on the Missouri River. Mr. Russell has served as president of the St. Louis Section.

Revised Lantern Lecture Released

THE SOCIETY's lantern lecture on "Mississippi River Flood Control" has just been returned to the list of lantern lectures available to Student Chapters. The original lecture, prepared by Edgar Jadwin, M. Am. Soc. C.E., in 1929, was very popular and enjoyed wide circulation among the Chapters. Major changes in policy governing the work on the Mississippi, however, made necessary a revision and therefore the lecture was withdrawn from circulation for a time. The revision has now been completed through the courtesy of Edward M. Markham, M. Am. Soc. C.E., Chief of Engineers, U. S. Army. The detailed changes were made by

George B. Pillsbury, M. Am. Soc. C.E., Assistant Chief of Engineers, and members of his staff.

The Society is fortunate in having the assistance of these members in bringing this authoritative lecture up to date and it is hoped that the Student Chapters will utilize it freely to inform their members of the methods, principles, and policies that apply to this great work. The lecture now consists of 19 pages accompanied by 60 slides. Reservations may be made in the usual manner beginning at once.



Plant for Constructing and Sinking Asphalt Revetment on the Mississippi

Asphalt from the Hoppers at the Right Is Tamped Into the Reinforcing Material to Produce a Mat

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

Flood Relief Upsets Government Budget

Almost unprecedented storms and floods struck enough of the eastern states recently to weaken or eliminate the resistance in Washington to continuation of huge appropriations. Some of the more threatening investigations of the activities of emergency agencies are about to be abandoned, and hearings involving more billions are crowding economy ideas and new schemes of taxation for attention.

With support of actual unexpected needs arising in the newly stricken areas and the emotional reactions from other parts of the country, it begins to look as if the Public Works Administration may get $750,000,000 to complete its commitments, and $1,500,000,000 might be appropriated for the continuation of other emergency activities.

Congress has not confined its generosity to relief and emergency appropriations. It is weakening under pressure to increase the appropriations for the regular departments, and extras are accumulating in pending deficiency measures. So, despite economic improvement and good intentions, expenses are rising faster than revenues, and the outlook for the next fiscal year is as much as two billion dollars out of balance.

Evidences of a behind-the-scenes trend toward balancing the budget continue, but its realization now looks to be several years away. Campaign-year commitments are likely to carry federal government financing of spending well into 1937 and lead to further inflation of the credit base. Conditions are improving rapidly enough, however, to prevent any collapse of government credit within the visible future.

Sentiment "on the Hill" is decidedly favorable to the Public Works Administration type of spending with a policy similar to the present grant and 4 per cent loan basis, but members of Congress do not support it exclusively because it has not been made applicable to the smaller communities and because of personal difference with Secretary Ickes. They want to discourage undertakings like the Florida Canal and Passamaquoddy but will vote to continue to completion the average project already under construction.

Charges of inefficiency, waste, and the indirect use of relief funds for political purposes continue to be charged against the Works Progress Administration. Criticism emphasizes the fact, however, that the goal for the distribution of funds on a work relief basis has been attained where other agencies have failed to provide the expected employment for the heads of relief families.

Activities of Other Government Agencies

No changes in policies have been announced by the Procurement Division of the Treasury. They have committed themselves to the limit of their appropriations and are furloughing designing engineers and architects until they know what funds are to be made available. Their program is comparatively free from criticism here, and observers agree that it is likely to be continued.

A large portion of the new appropriations is likely to go to reclamation under pressure from the West and western members of Congress. Little criticism of reclamation work is heard in Washington, and where the projects mesh in with soil erosion control, soil conservation, and land utilization the comment is favorable. The momentum from the able leadership of Dr. Mead carries its activities on in expectation that another strong engineer executive will continue the constructive policies.

The sound economical purposes of the current agitation for the reorganization and consolidation of departments and agencies of the federal government are confused with political strategy. The studies are scheduled to be made by the Brookings Institution under the direction of Senator Byrd's committee, headed by Dr. Louis Brownlow of Chicago, but the leaders of the movement admit its lack of organization and are admittedly doubtful about its success. Council has placed the recommendations of its committees and its files of valuable factual information at the disposal of Senator Byrd's committee and the Brookings Institution. So much of what could be done, however, depends upon political pressure, and the organization of the work of the committee is proceeding so haltingly that no action is expected until after the election.

Council for Industrial Cooperation

The staff has been in close contact with Maj. George L. Berry's Council for Industrial Cooperation. It is supposed to have been organized at the request of the President to develop a closer understanding between government, labor, and industry, and an acceptable application of some of the better phases of the "late" National Recovery Administration. But its non-partisan character seems open to question. An executive order has created two new units out of the NRA skeleton—the Committee of Industrial Analysis and a Council of Industrial Progress. Both appear to be aimed at new legislation governing wages and hours in the next session of Congress.

It has been "officially rumored" that the President is anxious to have practical recommendations for at least a partial elimination of government competition. In any event, $40,000 of the Emergency Relief Appropriation of 1935 has been reserved for the continuation of Coordinator Berry's activities.

Committee Activities of Council

Almost every engineer invited to serve on Council's committees has accepted and some committees are becoming active. The new program will be formally inaugurated by the executive committee at its meeting in Washington during the last week in April and presented as cases for consideration to the several committees. That will include the new state public affairs contact committee, which is being created to stimulate an increasing interest in public affairs through the promotion and support of state and local public affairs committees and to serve as a clearing house, in both directions, for sound ideas and factual information along engineering and economic lines.

Preview of Proceedings

By HAROLD T. LARSEN, *Editor*

In its final form the April issue of "Proceedings" developed into an even greater "discussions" number than was predicted in this column last month. At the last minute Mr. Ivan Rosov, author of a paper entitled "Pre-stressed Reinforced Concrete and Its Possibilities," found that he needed more time to include the results of important up-to-date findings. Consequently it will be several months before that paper is released. The May issue of "Proceedings" will contain an important paper in the field of hydraulics and, if time and space permit, a paper on the subject of structural design as affected by earth shocks.

GENERAL SOLUTION FOR BACKWATER AND DROP-DOWN CURVES IN UNIFORM CHANNELS

A most interesting theoretical and experimental paper in hydraulics is presented by Nagaho Mononobe, M. Am. Soc. C.E., professor in the civil engineering department of the Tokyo Imperial University in Japan. This paper includes a comprehensive formula for use in tracing backwater and drop-down curves. The formula is compared with numerous other equations and current views and, with telling logic, the author supports his claim that for the most part formulas now in use are entirely inadequate and yield excessive errors. The author furthermore supports his formula by a series of curves in which the other equations are plotted for comparison. Finally he describes a comprehensive series of tests and presents tabular data to establish the reliability of the suggested equation. Toward the end of his paper, Dr. Mononobe takes up a detailed criticism of current formulas now in use, appraising the extent to which their use will involve errors of a practical and serious nature.

Incidentally, he takes occasion to call attention to the important comparable work performed independently by B. A. Bakhmeteff, M. Am. Soc. C.E., which was published under the title "Hydraulics of Open Channels." It is not too much to anticipate that the present paper, so scholarly in approach and comprehensive in its scope, will command an unusual amount of discussion.

DYNAMIC DISTORTIONS IN STRUCTURES SUBJECTED TO EARTH SHOCKS

The phenomena relating to earth-shock vibrations are of interest and importance to the structural engineer practicing in a territory subjected to earth movements. An interesting phase of the subject is treated by H. A. Williams, Assoc. M. Am. Soc. C.E., in a paper entitled "Dynamic Distortions in Structures Subjected to Sudden Earth Shocks." The problem of designing structures so that they will resist earth shocks within reasonable limits is in a state of flux. In general, there may be said to be two schools of thought—that in which the structure is assumed to be rigid, and that which involves an elastic yielding structure. The first school seems to be popular with many engineers because of its simplicity. On the other hand, the dynamical methods are not popular due to the fact that most civil engineers are trained in statics and lack a proper fundamental conception of the dynamics of this general problem. One view is that it is scarcely possible for a structure to be distorted critically when its period is the same as that of the ground because the motion of the latter is subjected to radical changes at frequent intervals. Mr. Williams has attempted to show that this view is likely to be erroneous for single mass structures.

The mathematical theory upon which the interpretations of Mr. Williams' research are based may be found in a paper by L. S. Jacobsen entitled "Vibration Research at Stanford University," in the bulletin of the Seismological Society of America, Vol. 19, March 1929. The fact that the mathematical results do agree with the tests reported in this paper should be helpful to engineers who have any serious doubt concerning the validity of theory as applied to earthquake vibrations. Valuable data are presented in the form of curves.

DISCUSSION FROM ABROAD

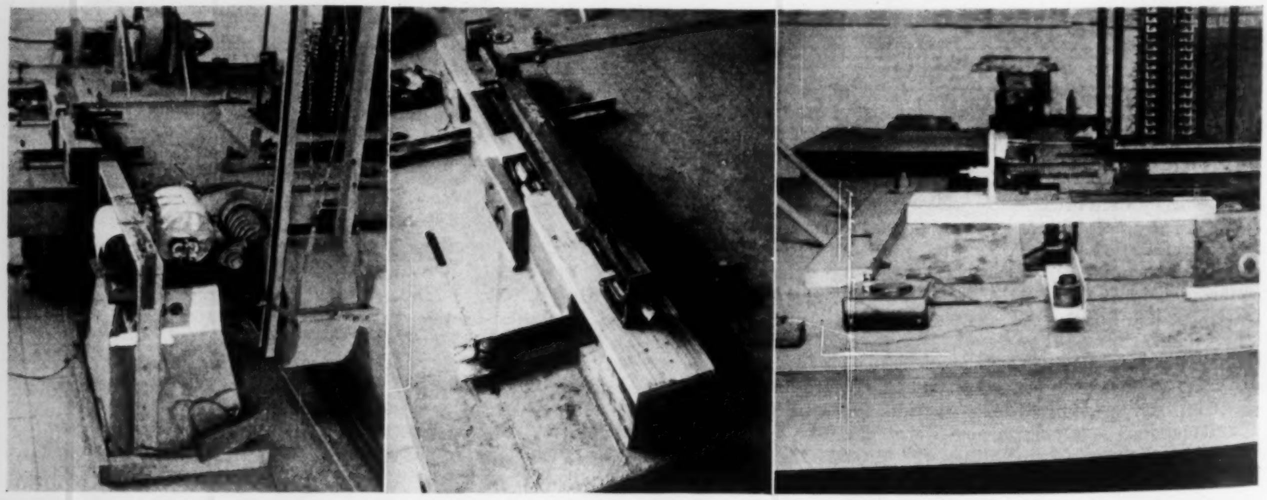
In the course of its discussion, the Jarvis paper has commanded a wide interest, particularly in view of the number of contributions from abroad. An especially valuable and interesting observation on the subject is being presented in the May issue by Kalem Bey Osman Ghaleb, Inspector General of Irrigation, Lower Egypt, who for ten years has been connected with the Nilometer on Roda Island, on behalf of both the irrigation department and the Committee for the Preservation of Arabic Monuments. H. E. Hurst, Director-General of the Physical Department, Ministry of Public Works at Cairo, discussed the paper ably in the December issue of PROCEEDINGS.

With the publication of the May number, PROCEEDINGS begins its summer recess to allow the staff to concentrate on the compilation of Volume 101 of TRANSACTIONS. The May issue will contain as many discussions as can be handled before the dead line, in this way avoiding the long delay before the August number.

Appointments of Society Representatives

WILLIAM H. CHORLTON, B. F. HASTINGS, and SCOTT B. LILLY, Members Am. Soc. C.E., represented the Society at the annual meeting of the American Academy of Political and Social Science, held in Philadelphia on April 24 and 25.

A. V. HUGO VON HEIDENSTAM, M. Am. Soc. C.E., will represent the Society at the seventy-fifth anniversary of the Svenska Teknologforeningen, to be celebrated in Stockholm, Sweden, May 19 and 20, 1936.



VIEWS OF MODEL INSTALLED ON SHAKING TABLE TO REPRESENT DYNAMIC EQUIVALENT OF SINGLE-MASS STRUCTURE

News of Local Sections

Alabama Section

A joint meeting of the Alabama Section and the University of Alabama Student Chapter was held in the university cafeteria at Tuscaloosa, Ala., on March 16. Frederick H. McDonald, Director of the Society, was present and helped the Section determine the proper make-up of its membership committee. On formal motion it was voted that Donald C. A. Du Plantier be appointed a delegate to the Spring Meeting of the Society at Hot Springs, Ark. The meeting concluded with a short discussion of the Engineers' License Law.

Cincinnati Section

A dinner meeting of the Cincinnati Section was held on April 6 at the University of Cincinnati Y. M. C. A. The speaker of the evening was Albert S. Hibbs, superintendent of the Cincinnati Department of Water. Mr. Hibbs gave an interesting illustrated talk on the Cincinnati water works, making special reference to the extensive improvement program now being undertaken. There were 30 present.

Illinois Section

A special luncheon meeting of the Illinois Section was held at the Chicago Engineers' Club on January 29 in honor of President Mead. There was an attendance of 47, which was unusually large. Dr. Mead spoke at some length on standards of ethics for the engineering profession and emphasized the duty of members of the profession to maintain these standards.

Iowa Section

The Iowa Section met at Marshalltown, Iowa, on March 10. Professors J. S. Dodds, E. L. Waterman, and H. E. Wessman gave reports on the Annual Meeting of the Society held in New York in January. The feature of the occasion was the presentation of a paper on trends in motor-vehicle taxation of concern to the engineer by R. A. Moyer, associate professor of highway engineering at Iowa State College. Professor Moyer called attention to the problem of financing future highway improvements and invited the engineering profession to aid in their solution. There were 40 present.

Ithaca Section

The Ithaca Section of the Society and the Broome Area Chapter of the New York State Society of Professional Engineers held a joint dinner meeting at the Bennett Hotel in Binghamton on March 31. There were 70 members and guests present. The speaker and guest of honor was John C. Riedel, deputy chief engineer of the New York City Board of Estimate and Apportionment and president of the New York State Society of Professional Engineers. Mr. Riedel gave an illustrated talk on the construction of the Brooklyn storm sewer. The committee on arrangements consisted of John A. Giles, E. E. Stickney, and Roy S. Barton.

Kansas City (Mo.) Section

There were 38 present at a meeting of the Kansas City (Mo.) Section held at the Hotel Kansas Citian on March 20. Robert P. Woods, president of the Section, after commenting briefly on the recent activities and work of the Section, introduced Henry E. Riggs. Dr. Riggs, who is Vice-President of the Society and honorary professor of civil engineering at the University of Michigan, gave a talk on the growth of the Society.

Kansas State Section

On March 19 a meeting of the Kansas State Section was held at the Hotel Kansan in Topeka. There were 22 present, including members of the Kansas State College Student Chapter. The feature of the occasion was a talk by Henry E. Riggs, Vice-President of the Society, who gave a résumé of the early history of the Society and outlined its present plans.

Los Angeles Section

The April meeting of the Los Angeles Section was held at the University Club on the 8th, with 153 in attendance. A topic of outstanding interest to Pacific Coast engineers—the relationship between the United States and China—was discussed, the speaker being Arthur G. Coons, dean of men at Occidental College. Dr. Coons traced the almost continuous growth of friendship between the two countries since the earliest contacts of the Yankee traders. The Section was also fortunate in being able to witness a talking motion picture presented by Charles Smith, of Pan-American Airways, showing the route followed by the "China Clipper" from California to Manila. The Junior Forum of the Los Angeles Section heard a talk on the restoration of the disintegrating Spanish missions, California's most interesting historical landmarks. This talk was given by Horace P. Hinckley, who directed one of these restoration projects.

Metropolitan Section

More than 400 were present at a meeting of the Metropolitan Section held in the Engineering Societies Building in New York City on March 18. A paper on the subject of sewage treatment in New York City by Walter D. Binger, deputy commissioner of sanitation of New York, and Richard H. Gould, engineer in charge of the New York City Department of Sanitation, was read. In this paper the general program of the department was outlined, and the benefits deriving from the new sewage treatment plants at Ward's Island and Coney Island were emphasized. Among those participating in the discussion were Arthur S. Tuttle, Past-President of the Society, Sol Pincus, and George A. Soper.

At a meeting of the Section held on April 15 an illustrated talk on the teredo threat in New York harbor was given by Prof. William F. Clapp, of Massachusetts Institute of Technology. Professor Clapp predicted that the direct consequence of eliminating pollution from the harbor will be an infestation of this type of marine borer. In the discussion that followed, it was pointed out that creosoting the piles and other submerged timber is the only effective preventive at present known for the attacks of the teredo. There were about 300 present.

New Mexico Section

A meeting of the New Mexico Section was called to order in Albuquerque on December 16, 1935. During the business session the following officers for 1936 were elected: J. H. Dorroh, president; F. G. Healy, first vice-president; R. H. Rupkey, second vice-president; and H. A. Wood, secretary-treasurer. The speaker for the occasion was Walter E. Jessup, Field Secretary of the Society, who talked on the subject of broadening the scope of Society activities. An enthusiastic discussion followed. At a meeting of the Section held in Santa Fé on January 22, 1936, six reels of motion pictures depicting construction progress on Boulder Dam were shown.

Northwestern Section

There were 25 present at a meeting of the Northwestern Section held on March 18. The feature of the occasion was a talk by George Schroepfer, assistant chief engineer of the Minneapolis–St. Paul Sanitary District, who described the Minneapolis–St. Paul sewage disposal project. Mr. Schroepfer's talk was illustrated with a number of slides showing the construction work on the project, which will consist of some 53 miles of intercepting sewers and a chemical treatment plant.

Panama Section

During the past months members of the Panama Section enjoyed several inspection trips to points of engineering interest. On February 16 they visited Madden Dam to see the cavitation of the sluiceways resulting from floods and the repairs being made on them. On March 1 an inspection trip was made to Gamboa, a new town site for the dredging division of the Panama Canal. The Section held a smoker at the Miramar Club in Panama City on March 20 in honor of John F. Stevens, Past-President of the Society and former chief engineer of the Isthmian Canal Commission. Mr. Stevens gave an interesting talk on matters connected with the construction of the canal.

Philadelphia Section

The story of the men who build, maintain, and operate the ships in the U. S. Navy was presented at a dinner meeting of the Philadelphia Section held on March 18. The chairman of the meeting was Capt. L. M. Atkins, of the Construction Corps, who gave an outline of the engineering organization of the Philadelphia Navy Yard. Lieutenant Commander S. E. Dudley described the necessary engineering steps in the planning of a new vessel; Capt. H. F. D. Davis, who was an engineer on the first electrically driven battleship, explained the development of the various methods of propelling ships; and Lieutenant Commander H. N. Wallin traced the growth of welding in ship construction. There were 57 present at the dinner, and 155 at the meeting following it.

PORTLAND (ORE.) SECTION

There were 23 present at a regular meeting of the Portland (Ore.) Section held at the University Club on March 20. Gage Haselton, chairman of the Committee on Junior Activities, gave a report on the work of this committee and stated that an organization of recent engineering graduates had been formed and a chairman elected. The speaker of the occasion was E. C. Lathrop, technical director of the Crown-Zellerbach Corporation, who gave an illustrated talk on the various processes involved in the manufacture of pulp and paper. A lengthy discussion from the floor followed.

PROVIDENCE SECTION

On March 19 a meeting of the Providence Section was held in the Engineering Society Building, with Warren G. Baxter acting as chairman. The speaker of the occasion was Mason J. Young, of the Corps of Engineers, U. S. Army, who spoke on "Developing the Connecticut River." This was a résumé of the U. S. War Department's reports on the utilization of the waters of this stream. Major Young discussed the existing and proposed federal projects for the development of the Connecticut Valley and their relationship to water-supply and hydro-electric projects. There were 60 present.

SACRAMENTO SECTION

During February the Sacramento Section followed its custom of holding weekly luncheon meetings. On February 4 the meeting was addressed by M. J. Brickley, professor of history at the Sacramento Junior College, who discussed the Italian invasion of Ethiopia. The speaker at the meeting held on February 11 was Henry Holsinger, attorney for the Division of Water Resources of the California State Department of Public Works. Mr. Holsinger described the present trend of the California water law and outlined the types of law existing in the western states. On February 18, I. Alvin Oliver, chief engineer of the Pomona Pump Company, came from Los Angeles to address the members of the Section. At the meeting held on February 25 the speaker was Asa G. Proctor, a member of the State Board of Registration for Civil Engineers. The attendance on these occasions ranged from 38 to 48.

SAN DIEGO SECTION

The March meeting of the San Diego Section was held at Vincent's Cafe, on the 26th. The feature of the occasion was a talk on the subject of steady-flow traffic, given by W. W. Crosby, consulting engineer of Coronado, Calif. Colonel Crosby emphasized the fact that engineers could do much to prevent accidents by proper highway design, and suggested that the factors of safety and efficiency are not incompatible. A general discussion followed from the floor. There were 15 present. The February meeting of the Section was held at Vincent's Cafe. At this session the members heard an interesting talk on the high lights of the Metropolitan Water District's aqueduct

ST. LOUIS SECTION

The regular monthly luncheon meeting of the St. Louis Section, held at the Mayfair Hotel on March 4, was enlivened by an illustrated talk on the subject of termite control. This was given by Albert W. Meyer, manager of the termite control division of the Contract Waterproofing Company, who stressed the point that termite control is a construction rather than an entomological problem. There were 40 members and guests present.

SYRACUSE SECTION

The Syracuse Section held a dinner meeting in the Onondaga Hotel on March 23 in honor of Capt. Donald B. MacMillan. After dinner Captain MacMillan gave an illustrated talk on his Arctic explorations before a joint meeting of the Section and the Technology Club of Syracuse. About 900 attended the lecture.

TACOMA SECTION

There were 24 present at a dinner meeting of the Tacoma Section held at the Tacoma Hotel on March 9. The first speaker on the program was Ivan C. Crawford, Director of the Society, who gave a complete report on the varied activities of the Society. Then Arthur Johnson spoke on the aims and activities of the Tennessee Valley Authority. A discussion followed from the floor. During the business session a round-table discussion of matters pertaining to the Section proved interesting and instructive.

TEXAS SECTION

The spring meeting of the Texas Section was held on March 13 and 14. On the first day registration took place at the Casa de Palmas Hotel in McAllen, Tex. After opening speeches, a technical paper on the subject, "The Use of Bituminous Materials in Repairing the Jetties at the Entrance of Galveston Harbor," was presented by A. D. Stivers, district manager of the asphalt sales department of the Texas Company. During the afternoon session the Maverick County water control project at Eagle Pass, Tex., was described by Ernest L. Myers, consulting civil engineer of Dallas. The next paper, which was on "Flood Control in the Lower Rio Grande Valley," was presented by J. L. Lytel, project engineer for the International Boundary Commission. Both papers were enthusiastically discussed. In the evening a dinner dance, which was held in Reynosa, Mexico, was enjoyed. On Saturday morning, March 14, the members motored to Brownsville, Tex., where they met in the Chamber of Commerce Assembly Room. There a paper on "Harbor Improvements at Brownsville" was presented by R. J. Cummins, consulting engineer of Houston, Tex. In the afternoon an inspection trip was made to various points of local interest, including the turning basin and the dock facilities under construction. The total attendance was 70.

Student Chapter Notes

RHODE ISLAND STATE COLLEGE

A joint meeting of the Rhode Island State College Student Chapter and the student branch of the American Society of Mechanical Engineers was held on March 19. An interesting talk on the Grand Coulee Dam was given by L. M. Colwell, district manager of the Jeffrey Manufacturing Company. Mr. Colwell illustrated his talk with both slides and moving pictures. There were 66 present.

UNIVERSITY OF NEBRASKA

The University of Nebraska Student Chapter held a dinner meeting on November 25, 1935. The speaker and guest of honor on this occasion was Walter E. Jessup, Field Secretary of the Society. Another dinner meeting was held on March 11, 1936, in honor of John G. Mason, state bridge engineer in the Nebraska Department of Roads and Irrigation. Mr. Mason is also contact member for the Student Chapter. The accompanying group photograph of the members of the Chapter was taken in December 1935.

MEMBERS OF UNIVERSITY OF NEBRASKA STUDENT CHAPTER

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for June

Among the articles scheduled for the June issue of Civil Engineering is one by R. E. Bakenhus, M. Am. Soc. C.E., Rear-Admiral, Civil Engineer Corps, U. S. Navy, on the subject, "Public Works of the Navy." To maintain the 600 vessels and numerous aircraft of the Navy and to care for its personnel, there are today no less than 329 shore stations. Such structures as ship yards; repair shops; docks; marine railways; submarine bases; air, ordnance, and radio stations; oil and coal supply stations; barracks; training stations; hospitals; prisons; and even cemeteries make up the shore stations. The construction and maintenance of all of these is the responsibility of the Civil Engineer Corps. The provision of the electric power necessary for operation of the stations is also a part of the Corps' responsibility, where such power is generated at the Navy's own central plants.

Some of the methods used in the correction of soil erosion today, notably construction of check dams, were employed on the American continent by the Mayas, Aztecs, and Incas, and in Europe by the inhabitants of the Swiss Alps following the disastrous flood of 1499. In an interesting article, Paul Baumann, M. Am. Soc. C.E., junior assistant chief engineer, Los Angeles County Flood Control District, discusses the function and design of the modern check dam. By stabilizing stream beds and side slopes, check-dam systems not only reduce direct erosion caused by the cutting action of stream flow, but also encourage the growth of vegetation, which assists indirectly in soil conservation and flood protection by limiting runoff.

The new cantilever bridge across the Mississippi at New Orleans, opened on December 16, 1935, is the eleventh major crossing to be completed between St. Louis and the Gulf. Harry J. Engel, Jun. Am. Soc. C.E., assistant engineer, Modjeski, Masters, and Case, Inc., is the author of an article on some of the features of these bridges. The first to be constructed was the arched Eads Bridge at St. Louis, opened in 1874. The other three St. Louis structures are made up of simple spans, and the Cape Girardeau Bridge uses continuous spans. Elsewhere the cantilever principle is employed, often with ingenious variations. A study of the various bridges illustrates the structural advances made in the past sixty years, as well as the progressive deterioration of foundation conditions and increasing demands of navigation encountered toward the mouth of the river.

F. Merryfield, Assoc. M. Am. Soc. C.E., assistant professor of civil engineering at Oregon State College, contributes an article on the "Treatment and Recovery of Sulfite Waste." Tests indicate that alleviation of stream pollution may be secured through ponding and aeration, but no process for the recovery of sulfite liquor has yet been developed which is economically attractive to the pulp and paper industry, the principal producers of sulfite waste.

Third World Power Conference to Be Held in Washington, D.C.

The Third World Power Conference, also the first of the series to be held in this country, will take place in Washington, D.C., on September 7 to 12, 1936. National power economy will be discussed from the angle of organization, control, public regulation, and related aspects. A special effort is being made to secure a large attendance from Latin-American countries as well as from Europe and Asia. The Second Congress on Large Dams will be held jointly with the conference.

The American National Committee in charge of the conference includes representatives of engineering and technical associations; trade associations of the electrical, coal, gas, and petroleum industries; public utility corporations; government bodies dealing with power and power resources; technical schools; engineers, economists, and spokesmen for labor and the consumer. Secretary Harold L. Ickes is chairman of the committee. A transcontinental tour to the more important sites of power development, and a number of shorter tours as well, have been arranged in connection with the conference.

Maps as Subjects of Postage Stamps

The frequent use of maps as motifs for postage stamps is not generally appreciated. From our own United States to Tannou Touva, in innermost Asia, and from Iceland in the Arctic to the Falkland Islands on the fringe of the Antarctic, map stamps have been issued by some 65 stamp-issuing countries and colonies throughout the world.

The first map stamp was issued by Panama in 1878, then a state within Colombia. Today this small country leads all others in numbers and varieties produced. In recent years, great impetus has been given to the issuing of map stamps by historic airplane flights, and by the establishment of air mail routes.

The frontispiece for this issue has been carefully selected from the collection of Paul Preston Rice, Assoc. M. Am. Soc. C.E., Lafayette College, Easton, Pa., to show a number of interesting facts concerning map stamps within the limits of the small number that can be reproduced on a page. Small special collections of map stamps on the following subjects, among others, may be assembled: Territorial expansion; historic airplane and dirigible flights; boundary disputes; annexations; scientific and geographical expeditions and societies; globes; ancient and modern maps; islands. It is interesting to note that the maps of some small islands are depicted in greater detail on stamps than on large world maps, where they appear as a mere dot. See No. 2, of St. Helena; No. 8, of Ascension Island; and No. 23, of the Cayman Islands.

It is to be regretted that the Treasury Department regulations permit the reproduction of only limited portions of United States stamps at twice the original size. Thus, our own interesting map stamps cannot be satisfactorily shown. In compliance with U. S. Postal Regulations each engraving has been defaced by a white score line.

A collection of stamps illustrating famous ancient and modern bridges appeared as the page of special interest in the July 1933 issue.

New York Legislature Considers Projects Study Bill

A bill designed to insure social and economic as well as engineering soundness in public works projects has been introduced in the New York State Legislature by State Senator T. C. Desmond, M. Am. Soc. C.E. The bill would permit the governor, or state agencies, or local legislative bodies, to employ independent engineers to check in advance the technical and other features of public plans.

These independent engineers could be retained whenever a public project was contemplated or authorized by the state or any of its subdivisions, and they would be empowered to study and report on such matters as the feasibility of the project, the extent of the public benefit that would accrue from it, the suitability of the selected site, desirable changes in plans and specifications, the reasonable cost of the project as planned, and the probable cost of a recommended substitute. They might also be employed in connection with a long-range program covering a progressive series of state projects, or they might be authorized to make studies for the better conservation and use of state or local natural resources.

Although the recommendations of the independent engineers would not be binding, they would be required under the proposed law to be published in a newspaper of general circulation, and would thus be made available for public scrutiny.

International Association for Research on Hydraulic Structures

By HERBERT N. EATON

CHIEF, NATIONAL HYDRAULIC LABORATORY, NATIONAL BUREAU OF STANDARDS, WASHINGTON, D.C.

THE INTERNATIONAL ASSOCIATION for Research on Hydraulic Structures was founded at Brussels in September 1935, on the occasion of the meeting of the Sixteenth International Navigation Congress. The creation of this new international organization marks the culmination of five years' effort on the part of European hydraulic engineers to establish a body having as its purpose the interchange of the results of research on hydraulic structures and the publication of papers in which the results of such research would be presented.

The first definite proposal that such an association be established appears to be found in a resolution offered by Prof. Friedrich Schaffernak of Vienna at the meetings of the World Power Conference in Berlin in 1930. This resolution read as follows: [*Resolved that*] "an organization be established for the purpose of interchanging, in the field of hydraulic engineering, the results of laboratory research and of observations of the natural conditions pertaining thereto."

Although the wording of the resolution does not make it entirely clear, the intent seems to have been to restrict the field of interest of the proposed organization to model tests of hydraulic structures and to the verification of the results obtained with the models by observations made on the corresponding full-scale structures. Prof. Anton Smrček of Brünn also presented at this time a somewhat similar resolution, relating mainly, however, to the publication of results.

Another proposal was made by A. Genthial, general secretary of the International Commission on Large Dams at the meeting of the World Power Conference at Berlin in 1930. His resolution read, "The experimental investigations on dam engineering ought to include, in as many cases as possible, laboratory tests on models made to scale." While this resolution does not specifically suggest the international exchange of information, nevertheless this would seem to be implied.

A somewhat similar action was taken at the Fifteenth International Navigation Congress at Venice in 1931, at which the followings points were formulated:

"(*a*) It would be very useful to establish a permanent connection between the hydraulic laboratories for the different countries.

"(*b*) The agenda of the next Navigation Congress should include a question reading as follows:

"Study of hydrotechnical questions by laboratory tests or models built to scale. Comparison of the experimental results with observations in nature, particularly in order to investigate the accuracy of the law of similitude.' "

Dr. Schaffernak's proposal was referred to the Swedish National Committee of the World Power Conference for a report and recommendations to be presented to the Sectional Meeting of the World Power Conference at Stockholm in 1933. The Swedish National Committee appointed a subcommittee headed by Prof. Wolmar Fellenius of Stockholm to deal with this matter. After correspondence with hydraulic engineers all over the world, this subcommittee called a meeting at Berlin in January 1933 at which the principal interests of hydraulic engineers and experimenters were formulated with the idea that the proposed association should undertake to meet these needs by facilitating the interchange of information, by encouraging the publication of results, and by holding meetings. These interests were listed as follows, in order of importance:

"(1) The result of the practical application of the information obtained from tests to actual structures; that is, a verification of the predictions made from model tests, provided these have been carried out.

"(2) The publication of the results of purely scientific investigations, even if the results do not have a practical application in engineering.

"(3) Finally, statements regarding investigations which are current in the individual institutions. The list published in the V.D.I. Zeitschrift for October 1932, can serve as a model of this." (This is somewhat similar to the reports of research listed in the National Bureau of Standards Hydraulic Laboratory Bulletin, Series A, "Current Hydraulic Laboratory Research in the United States.")

A proposed plan of organization was drawn up and this was presented through the Swedish National Committee in its report to the International Executive Council of the World Power Conference at Stockholm in June 1933. This report was rejected by the council because the latter did not approve of the plan of organization or the proposed method of financing. No further action was taken until 1935, when the International Association for Research on Hydraulic Structures was founded.

The scope of the association's interests has not yet been defined clearly. However, those engineers who have been most active in bringing about the formation of this body have taken a strong stand for restricting these interests in the sense of the Schaffernak resolution; that is, to the results of model tests of hydraulic structures and to the verification of these results by tests on the prototypes. Research on hydraulic machinery and on ship models would be excluded. This is a question on which American engineers who join the association should be prepared to take a definite stand when the first meeting of the association is held.

The plan of organization adopted at Brussels provides for two classes of membership—individual members and corporate members. The following provisions relating to membership are quoted from the proposed articles of association:

"Any one who is interested in hydraulic research can become an individual member if he is: (*a*) Professor of hydraulics or of any related subject at an engineering college, at a university, or at any other equivalent educational institution; "(*b*) director of a hydraulic laboratory or an employee holding an administrative position at such a laboratory; (*c*) member of a prominent scientific or engineering society.

"Corporate membership is open to: (*a*) Departments of hydraulics or of related subjects at an engineering college, at a university, or at an equivalent educational institution; (*b*) hydraulic laboratories; (*c*) national or other committees of the World Power Conference, of the International Congress on Large Dams, and of the Permanent International Association of Navigation Congresses; (*d*) public organizations that project, execute, and supervise hydraulic works." (A recent letter from the president of the association states that power companies will be considered eligible for corporate membership under (*d*).)"

The annual dues of individual members are 10 reichmarks, and the annual dues of corporate members are set at not less than 50 reichmarks. Prof. Wolmar Fellenius was elected President of the association at the Brussels meeting, and the following provisional permanent committee was chosen: J. Blockmans (Antwerp), C. Camichel (Toulouse), H. N. Eaton (Washington), J. B. Egiazaroff (Leningrad), W. Fellenius (Stockholm), A. H. Gibson (Manchester), E. Meyer-Peter (Zurich), Th. Rehbock (Karlsruhe), A. Rohringer (Budapest), F. Schaffernak (Vienna), E. Scimemi (Padua), R. Seifert (Berlin), J. Smetana (Prague), and H. Th. Thijsse (Delft). A provisional executive committee, consisting of Messrs. Fellenius, Seifert, and Thijsse, was also elected.

It is probable that the association will hold a meeting during 1936 at some central point in Europe in order to effect a permanent organization and to prepare plans for its first activities. Its first objective appears to be the arrangement of international meetings at intervals of from two to four years. Plans will undoubtedly be formulated also for the interchange of information on investigations, both completed and current, in the field of the association's interest.

A translation of the proposed articles of association adopted tentatively at the Brussels meeting will be found in the National Bureau of Standards Hydraulic Laboratory Bulletin, Series A, Vol. IV-1, January 1, 1936. Information and membership application blanks may be obtained by writing directly to the president of the association, Prof. Wolmar Fellenius, Kungl. Tekniska Högskolan, Stockholm, Sweden, or to the author of this article.

Failure of Suspension Bridge Cable Wire

AT THE 1936 annual meeting of the American Society for Testing Materials, to be held in Atlantic City June 29 to July 3, an interesting technical paper will be presented, giving the results of some recent comprehensive studies carried out at the National Bureau of Standards in Washington, D.C., on the failures of the cable wires of the Mt. Hope suspension bridge. This investigation necessitated dismantling the partially completed bridge. The wire first used, which failed in February 1929, had been brought to a strength of 220,000 lb per sq in. by quenching and tempering. It was sucessfully replaced by wire of about the same size, carbon content, and strength, but having this important difference, that it was cold drawn.

The paper, prepared by W. H. Swanger and G. F. Wohlgemuth of the Bureau of Standards, gives the solution of this most vexing problem and explains also why the cold-drawn wire did not fail. Numerous tensile, hardness, tension, and bend tests in the installed wire checked with tests prior to use, and extended microscopic studies disclosed no defective material or faulty heat treatment. Intensive search ruled out internal fissures as a cause. Thermomagnetic and other studies indicated no change in structure or properties after the final tempering treatment.

The failures had occurred at the anchorage, and further analysis showed that stress conditions at the anchorage were involved. Yet the cold-drawn wire with the same load has not failed. Thus, either the stress conditions in the first wire were different from those in the cold-drawn wire, or the latter could better resist such stresses. The Bureau studies show that both conditions obtained, and other studies show that fluctuating stresses did the damage. The authors give a detailed analysis of their findings, and also present clear evidence that the fibrous structure of the cold-drawn wire is a distinct advantage in applying it to this suspension structure.

Apparently the National Bureau of Standards has solved this mystery that has perplexed the engineering profession since 1929. The American Society for Testing Materials extends a cordial invitation to Society members, and particularly to those in the Structural Division, who may be able to attend. The session at which the paper will be given is scheduled for Thursday morning, July 2, at the Chalfonte-Haddon Hall Hotel.

Wise and Otherwise

WHILE conducting his course in bridges at the University of Calisota some years ago, Professor Abercrombie found that there were at the beginning of a certain term exactly 100 students. Four instructors were available, teaching arch, bascule, cantilever, and draw bridges, respectively. At the first gathering, Professor Abercrombie made the following announcement:

"Each student will choose one of the four subjects, which he must then study exclusively for one week. For each ensuing week there will be a new arrangement, the number studying any given subject not being the same for any two weeks. Each week the students studying arch and bascule bridges must together number 19; those studying bascule and cantilever, 55; and those studying cantilever and draw, 81. There must be at least one student taking each subject each week.

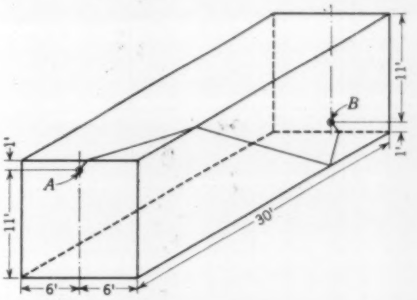


FIG. 1. DIAGRAM SHOWING SHORTEST DISTANCE BETWEEN POINTS *A* AND *B*

"This program is to continue for as many weeks as possible under the given conditions, after which we will revert to the usual schedule. You will work out the details yourselves, and will provide each instructor each Friday afternoon with a list of the students to be in his class during the following week."

The Professor's instructions were duly carried out. What was the smallest number taking draw bridges in any one week? How many students took bascule bridges during that same week? How many weeks did this variable arrangement continue?

April's problem involved the shortest surface distance between the points *A* and *B*, Fig. 1. The required distance is 40 ft, arrived at by development, in the following manner:

Sketch out the surfaces in the order, from top to bottom, of far lateral wall, ceiling with end wall at the left, near lateral wall, floor with end wall at the right. *A* and *B* will then appear on the end-wall center lines 1 ft from the ceiling and floor lines, respectively. Connect them with a straight line. This line forms the hypotenuse of a right-angled triangle 32 ft by 24 ft, and is thus 40 ft in length.

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should be enclosed in separate envelopes.

Comprehensive Water Plan Now Under Way

A "NATIONAL WATER PLAN" directed to the control of floods, erosion, and water pollution; to the uses of water for domestic purposes, irrigation, and power; and to the drainage of water-logged and overflowed lands, will be delivered to the President by the National Resources Committee before December 1, 1936, it was announced recently. This national plan will include a "developed" or long-range plan for each important drainage basin in the United States and a listing of projects for its execution.

The study, which has already been begun, is in line with the general recommendations made in the December 1934 report of the National Resources Board (outlined in the February 1935 issue of CIVIL ENGINEERING). Its director is Frederick H. Fowler, M. Am. Soc. C.E., a member of the Society's Committee on Flood Protection Data, and the assistant director is Merton L. Emerson, also a Member of the Society. Under them the Water Resources Committee is assigning 17 consultants to work with state and regional planning boards and to get the views of state authorities with respect to the needs of various sections of the country. These consultants will be responsible for the conduct of the field work necessary for the preparation of the plan in groups of states selected according to major drainage areas.

Pamphlet on Design of Concrete Floor Systems

A BOOKLET recently issued, entitled "Simplified Design of Concrete Floor Systems," provides a quick means for determining the relative economy of the one-way and two-way solid and ribbed slab types. This 86-page booklet gives formulas and tables in common use together with safe load tables for each of the types enumerated. Copies may be had without charge upon request to the Portland Cement Association, 33 West Grand Avenue, Chicago, Ill.

Brief Notes from Here and There

A PROFESSOR in a western college submits the following definition of datum plane, written by a freshman who it seems might prefer to remain anonymous: "A datum plane is a plane on which the level is set to distinguish the elevation and location of points on that plane. Notes taken on that plane may be called data."

* * * *

STUDENTS of civil engineering constituted 17.2 per cent of the entire 1934–1935 enrolment in 122 of the larger schools of engineering throughout the country, according to a report prepared by Frank Kerekes, M. Am. Soc. C.E., for the Civil Engineering Division of the Society for the Promotion of Engineering Education. In the same year the teaching personnel of the civil engineering departments included 19.6 per cent of the total number of persons engaged in engineering education. Professor Kerekes' analysis indicates that of each 100 freshmen enrolling in an engineering course, about 60 will complete four years of work; however, in last year's civil engineering classes there were more than 85 seniors for every 100 freshmen. This high percentage of upper classman, he suggests, may be caused by the large number of students who returned to finish their courses during the more severe depression years.

* * * *

THE KAPOK VEST has proved its value as a life saver in many construction accidents, the National Safety Council reports. A large eastern contractor has a record of 17 cases where men have fallen into the water while wearing kapok vests, and in each case the man was pulled out unharmed. A U. S. Engineer Department safety bulletin indicates that out of 41 drownings investigated, 17 could probably have been prevented had vests been worn, and in all but 3 cases a vest might have been of value.

NEWS OF ENGINEERS

From Correspondence and Society Files

ALLEN R. WILSON was elected president of the American Railway Engineering Association at its annual meeting held in Chicago from March 10 to 12. Two other Society members—F. E. MORROW and J. C. IRWIN—are among the 1936 officers. Mr. Morrow was elected second vice-president, and Mr. Irwin became first vice-president.

NORMAN J. CASTELLAN, formerly an instructor at the University of California, recently accepted an appointment as a junior engineer in the U. S. Bureau of Reclamation.

ALFRED J. ORSELLI is now field engineer for Six Companies, Inc., on the construction of the Broadway tunnel in Oakland, Calif.

JOHN B. DRISKO has taken a position with the Soil Conservation Service in the National Hydraulic Laboratory at Washington, D.C. The resulting vacancy in the U. S. Bureau of Reclamation's laboratory of hydraulic research has been filled by DONALD P. BARNES, former assistant engineer for the Bureau.

MELVILLE S. BITNER is now an assistant engineer in the U. S. Bureau of Reclamation in Denver, Colo.

OLAF LAURGAARD, formerly in the Denver office of the U. S. Bureau of Reclamation, is now office engineer for the Tennessee Valley Authority, with headquarters in Knoxville, Tenn.

HERBERT M. SHARP, formerly vice-president of the France Stone Company, of Toledo, Ohio, is now president of the Maumee Asphalt Paving Company of the same city.

HENRY J. MILLS, an engineer with the Metropolitan Water District of Southern California, has been transferred from work on the Cottonwood and Mecca Pass tunnels on the Colorado River aqueduct to the Pasadena tunnel. He will supervise the placing of concrete lining in the distribution system.

LINCOLN ELLSWORTH was awarded the Hubbard gold medal of the National Geographic Society on April 15, the presentation being made by President Roosevelt. The medal, which is the highest honor bestowed by that society, has been awarded in recognition of Mr. Ellsworth's Arctic and Antarctic explorations, particularly his recent flight over 2,200 miles of unexplored territory in Antarctica, between the Weddell and Ross seas. The accompanying photograph is reproduced through the courtesy of the American Museum of Natural History, of which Mr. Ellsworth is a trustee.

LINCOLN ELLSWORTH

WILLIAM J. O'CONNELL, JR., field and sales engineer for the Wallace and Tiernan Company, was recently transferred from the Newark, N.J., office of this organization to the San Francisco office, where he will serve as a technical specialist for the company in both the industrial and sanitary engineering fields.

CHARLES E. GRUBB has been appointed business administrator of the University of Delaware at Newark, Del.

REX L. FOSSNIGHT is now a junior engineer with the U. S. Bureau of Reclamation in Denver. He was formerly with Paulette and Wilson of Salina, Kans.

GARNER A. BECKETT, who formerly held the position of general manager of the Riverside Cement Company, of Los Angeles, Calif., has been made president of the same organization.

F. R. MCMILLAN, director of research for the Portland Cement Association, was elected president of the American Concrete Institute at its recent annual convention held in Chicago.

GORDON WALLACE was recently appointed chief engineer draftsman in the Public Works Department of the 3d Naval District, with headquarters in New York City.

EUGEN F. KRIEGSMAN is now acting state director for the Public Works Administration in Rhode Island, with headquarters in Providence. He was previously engineer examiner in the same service at Hartford, Conn.

ALEXANDER FOSTER, JR., was elected president of the National Sand and Gravel Association at its recent annual convention.

C. CLARKE KEELY has opened a civil engineering office in the Petroleum Securities Building at 714 West Olympic Boulevard in Los Angeles, Calif.

WILLIAM E. A. DOHERTY, formerly engineer of construction in the Philadelphia Bureau of Highways, has assumed new duties as engineer of maintenance in the Bureau.

ELY C. HUTCHINSON has joined the staff of the J. G. White Engineering Corporation of New York.

ROBERT M. BROOKS is at present employed as assistant road engineer for Five Civilized Tribes, Indian Roads, Muskogee, Okla. Previously he was with the Arkansas State Highway Department at Wynne, Ark.

ROY M. SNELL has been made resident engineer for the U. S. Bureau of Reclamation at Kennett Dam, near Redding, Calif.

CARL B. WIRSCHING has been named chairman of the general committee for the college of engineering at the University of Southern California, in Los Angeles, Calif.

DONALD S. BERRY, formerly in the State Highway Laboratory at Ann Arbor, Mich., is now assistant traffic engineer for the National Safety Council, with headquarters in Chicago, Ill.

GILBERT F. MELLIN, civil engineer of Sacramento, Calif., was recently appointed chief right-of-way appraiser to supervise the field work of a group of six appraisers on the Central Valley project of California.

CHARLES P. GROSS, lieutenant-colonel, Corps of Engineers, U. S. Army, has been detailed as an instructor in the Engineer School at Fort Beloir, Va., starting on August 15.

ALEX M. TORPEN, of San Francisco, Calif., has been appointed division engineer for the U. S. Bureau of Reclamation in charge of Friant Division of the Central Valley project.

LOUIS K. WHITCOMB, JR., has been transferred from the Cleveland district office of the Carnegie-Illinois Steel Corporation to the general sales office of the same organization. His headquarters are now in Pittsburgh, Pa.

CHARLES M. MORTON is now with Brown and Root, contractors of Austin, Tex. He was previously surveyor for Hays County, Texas.

Charles D. Curran, formerly technical supervisor for the Blackstone Valley flood control project, is now assistant director, Works Progress Administration of Massachusetts State Planning Projects, in charge of water resources studies. His headquarters are in Boston.

DECEASED

Onward Bates (M. '82; Hon. M. '23) who was president of the Society in 1909, died at his winter home in Augusta, Ga., on April 4, 1936, at the age of 86. A brief account of his life appears in the "Society Affairs" department of this issue.

Edward Gatling Bradbury (M. '09) for the past 20 years sanitary engineer for Franklin County, Ohio, died in Columbus on March 11, 1936. He was born in Brooklyn, N.Y., on June 14, 1870. In 1897, after varied engineering experience in Rhode Island and Massachusetts, he moved to Columbus where he was western representative of Snow and Barbour, of Boston. From 1905 until 1922 he was in private practice in Columbus, and from 1917 to the time of his death he served as sanitary engineer of Franklin County. Mr. Bradbury was the author of numerous papers on sanitary engineering subjects.

Ernest William Branch (M. '05) civil engineer and surveyor of Quincy, Mass., died in Daytona, Fla., on March 8, 1936. Mr. Branch, who was 73, was born in Smithfield, Me., on May 26, 1863. He graduated from Boston University in 1888 and entered the engineering and surveying office of H. T. Whitman, of Quincy, Mass., where he remained until 1896. From 1896 to 1905 he was chief engineer in charge of the design and construction of a sewerage system for the city of Quincy. In 1905 he opened a general engineering and surveying office, which he maintained until his death. During the World War Mr. Branch served as project engineer for the U. S. Housing Corporation.

Thane Ross Brown (Affiliate '00) of City Point, Wis., died on June 30, 1934. He was born at Oxford, Ohio, on June 21, 1870, and graduated from the University of Wisconsin in 1895, receiving the B.S. degree. Mr. Brown's early experience included surveying work in Wisconsin and Iowa. In November 1895 he became connected with the Wisconsin Bridge and Iron Company, where he remained until his retirement in 1932.

Albert Nelson Burch (M. '29) with the Division of Water Resources of the California State Department of Public Works, died at his home in Sacramento, Calif., on February 21, 1936. Mr. Burch was born at Fayette, Iowa, on June 21, 1864. In 1898 he became superintendent of the Stanislaus Water and Power Company at Oakdale, Calif., remaining there for almost ten years. In 1907 he was appointed irrigation engineer in the U. S. Reclamation Service at the Umatilla project in Oregon. Later he was transferred to the Orland project in California. From 1921 until 1927 Mr. Burch was a consultant in the Service and during part of this period was also employed by the State of California. In 1927 he returned to the state service as supervising hydraulic engineer in charge of irrigation district matters.

George J. Calder (M. '28) chief engineer for the American Toll Bridge Company and president of the Duncanson-Harrelson Company, died in Oakland, Calif., on March 18, 1936, at the age of 51. He was born in Sonora, Calif., on August 5, 1884, and graduated from the University of California in 1909. Among the important construction projects on which he served as resident engineer were the Sacramento filtration plant, the Carquinez bridge, and the new Mare Island causeway. In 1923 he joined the staff of the American Toll Bridge Company, becoming chief engineer in 1929. From 1928 until the time of his death he served as president of the Duncanson-Harrelson Company, a firm of bridge, dock, and wharf contractors.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

Frederick Davis (Assoc. M. '05), died in Santa Cruz, Calif., on January 25, 1936. He was born in Watkins, N.Y., in 1871. From 1887 to 1889 Mr. Davis was a student at Lehigh University. He was engaged in road building and general engineering work in Nicaragua from 1891 to 1898, and was with the Isthmian Canal Commission from 1898 to 1901. In 1902 he joined the staff of the Pennsylvania, New York, and Long Island Railroad Company, East River Division. About thirty years ago he went west to become manager of the Santa Cruz plant of the Portland Cement Company. Mr. Davis retired in 1933.

Robert Joseph Driscoll (Jun. '31) of Chicago, Ill., died on January 25, 1936. He was born at Logansport, Ind., on April 19, 1908, and graduated from Marquette University in 1930, receiving the C.E. degree. After taking a sales course with the Goulds Pumps, Inc., at Seneca Falls, N. Y., Mr. Driscoll—in May 1931—became sales engineer in the Chicago office of this organization.

Albert Bailey Drake (M. '95) civil engineer and surveyor of New Bedford, Mass., died in that city on September 26, 1935, at the age of 76. He was born in Mansfield, Mass., on February 24, 1859. Mr. Drake gained his early engineering experience in Arizona and New Mexico. In 1884 he was appointed city surveyor of New Bedford, and in 1889 he became superintendent of the board of public works of that city. From 1895 until his death he maintained an office as civil engineer and land surveyor in New Bedford.

Le Roy Frink Fairchild (M. '24) structural engineer for the Eastman Kodak Company of Rochester, N.Y., died on December 1, 1935, at the age of 49. He was born at Brooklyn, Pa., and studied at the University of Rochester and Cornell University. His early engineering experience was with the New York Central and Hudson River Railroad. In 1912 he became a draftsman for the Eastman Kodak Company. In 1917 he was promoted to the position of structural engineer in direct charge of the design of all building construction.

Giles Matthew Jowers (Assoc. M. '20) resident engineer in the Texas State Highway Department, died at his home in San Antonio, Tex., on March 24, 1936, at the age of 67. Mr. Jowers, who was born at Thomasville, Ala., received his engineering degree from the Armour School of Technology in Chicago. His early engineering experience included work with the San Antonio, Uvalde, and Gulf Railroad, the Interstate Commerce Commission, and the International Boundary Commission. During the World War Mr. Jowers served as an engineer for the government, laying out Kelly Field and Camp Travis. In 1920 he joined the staff of the Texas State Highway Department where he remained until his death.

William Datus Kelley (M. '87) died in Cleveland, Ohio, on January 21, 1936. He was born at Kelley's Island, Ohio, on May 11, 1859, and graduated from Cornell University in 1880. His early experience included work on the Croton aqueduct for the New York City water supply and surveying for the Intercontinental Railway Commission in South America under the U. S. War Department. The government published the results of this survey in two large volumes. In 1894 he became president of the engineering, building, and contracting company of Kelly and Kelley, Inc., of New York City, and of the Kelley-Demarest Construction Company, of Cleveland. In 1934 he retired. Mr. Kelley was the inventor of the first hinged arch center for the removal of sewer arches.

Carl Gustaf Emil Larsson (M. '03) of Plainfield, N.J., died at Winter Haven, Fla., on April 1, 1936, at the age of 71. He was born and educated in Sweden, coming to this country as a young man. In his early twenties he entered the employ of the Edgemoor Bridge Works of Wilmington, Del., which subsequently was merged with the American Bridge Company. He remained with the latter organization until his retirement in 1933, serving successively as division engineer, assistant chief engineer, and chief consulting engineer. He aided on the design and construction of the Hell Gate railroad bridge in New York and the Kill van Kull Bridge.

JAMES EDWIN PARKER (M. '22) assistant engineer for the Alabama Power Company of Birmingham, Ala., died recently. Mr. Parker was born in Birmingham on December 22, 1884. After graduating from Howard College (Birmingham) in 1903, he engaged in engineering work in the South for the Southern Railway and the Seaboard Air Line Railway. Among the later projects for which he was responsible were the design and construction of flood-protection systems for Augusta, Ga., and Chattanooga, Tenn., of dams and hydro-electric developments, and of water-works and sewerage systems for various municipalities. In 1920 he entered the employ of the Alabama Power Company, where he remained until his death.

LOUIS HENRY PRELL (M. '15) senior engineer at Fernbank Dam since 1930, died at his home at Saylor Park, Ohio, on March 18, 1936, at the age of 61. He was born in Cincinnati, Ohio, on October 28, 1874, and graduated from Ohio Normal University in 1902. Captain Prell was attached to the Cincinnati District of the Corps of Engineers, U. S. Army, from 1901 until his death. He was in charge of the construction of Dam No. 39 on the Ohio River from 1917 until 1921, and later had charge of completing Dam No. 38. In 1930 Captain Prell was promoted to the rank of senior engineer, and in 1933 was assigned in charge of the U. S. Engineer Depot at Fernbank.

BERNHARD ALEXANDER SMITH (M. '18) consulting engineer of Melbourne, Australia, died on March 1, 1936, at the age of 72. He was born in Stawell, Australia, and received an engineering degree from the University of Melbourne in 1890. Mr. Smith was responsible for the design and construction of numerous water-works, irrigation, reclamation, and construction projects in Australia. In 1902 he established a consulting engineering practice in Melbourne, where he designed and constructed many important buildings.

CHARLES LOUIS STROBEL (M. '79; Hon. M. '32) an engineer and leader in the development of skeleton steel construction for Chicago skyscrapers, died at his home in Chicago on April 5, 1936, at the age of 83. A brief account of his career is given in the "Society Affairs" department of this issue.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From March 10 to April 9, 1936, Inclusive

ADDITIONS TO MEMBERSHIP

ANDERSON, ALVIN GEORGE (Jun. '36), Junior Engr., SCS, U. S. Dept. of Agriculture, Dadeville, Ala.

ARNOLD, EMMONS LESLIE (Assoc. M. '36), Secy. and Treas.—Designing Engr., Pittsburgh Industrial Eng. Co. (Res., 7165 Upland St., Homewood), Pittsburgh, Pa.

BECKER, MORRIS (Jun. '36), Eng. Asst., Dept. of Water Supply, Gas and Electricity (Res., 6822 Nineteenth Ave.), Brooklyn, N.Y.

BENGTSON, THORE FRITJOF (Jun. '35), 2d Lieut., Corps of Engrs., U.S.A., Corozal, Canal Zone.

BLATT, JOSEPH DUV (Jun. '36), 3434 Knox Pl., New York, N.Y.

BRANSON, WALTER EUGENE (Jun. '35), 7333 Hermitage St., Pittsburgh, Pa.

BROUSSARD, WILSON (Jun. '36), Instrumentman, State Highway Comm., Box 814, Winnfield, La.

BUTLER, LEONARD JOHN (Jun. '36), 1601 East 10th St., Tucson, Ariz.

CHOCOLE, JOSEPH FRANK (Jun. '35), Draftsman, Chicago Bridge & Iron Works (Res., 9625 South Damen Ave.), Chicago, Ill.

COLLIER, WILLIAM PRESCOTT (Jun. '35), Box 58, Ephrata, Wash.

DODGE, ELDON RAYMOND (Jun. '36), Instr., Civ. Eng., Case School of Applied Science, Cleveland, Ohio.

DUNN, ROBERT (Jun. '35), 113 Luddington Ave., Clifton, N.J.

ERSKINE, HARLAN MERCER (Assoc. M. '36), Asst. Hydr. Engr., U. S. Geological Survey, Water Resources Branch, Box 206, Murphy, N.C.

FEIGE, HENRY THEINERT (Jun. '35), 17 East Collingswood Ave., Oaklyn, N.J.

FOCK, MO-LUN (Jun. '35), 248 Darroch Rd., Shanghai, China.

HACKETT, PERRY BRADBURY (Jun. '36), Instrumentman, State Highway Dept., Canton, Okla.

HORONJEFF, ROBERT (Jun. '35), With U. S. Bureau of Reclamation, 571 Orange Ave., Yuma, Ariz.

JUNIOR, FRANCIS EDMUND (Assoc. M. '36), Associate Highway Engr., TVA, Highway Section (Res., 1619 Magnolia Ave., Apartment H), Knoxville, Tenn.

KIRKPATRICK, WILLIAM (Assoc. M. '36), Supt., Filter Plants and Water Distrib., Water and Sewerage Board, Kingston (Res., 4 Marescaux Rd., Cross Roads P.O.), Jamaica.

KOZLOWSKI, EDWARD (Jun. '36), Instr., Civ. Eng., Lewis Inst. (Res., 6210 South Fairfield), Chicago, Ill.

KRAMER, HAROLD HENRY (Jun. '35), Timekeeper, Thomas Crimmins Contr. Co. (Res., 70 West 181st St.), New York, N.Y.

LINELL, KENNETH ANDREW (Jun. '35), 119 Forest St., Worcester, Mass.

LOPEZ DE ROMAÑA, EDUARDO CARLOS (Jun. '36), Box 98, Arequipa, Peru.

MCNEARY, WILLIAM JAMES LIPPINCOTT (Jun. '35), with R. A. Downes & Co. (Res., 1719 Mount Vernon St.), Philadelphia, Pa.

MORGAN, JOHN DWIGHT (Assoc. M. '36), Senior Estimator, WPA, Dist. 4, Texas (Res., 4308 Gilbert Ave.), Dallas, Tex.

MYERS, EARL COLEMAN, JR. (Jun. '35), Care, SCS, Watershed and Hydrologic Studies, Box 403, Temple, Tex.

NERDAHL, LOYAL MELVIN (Jun. '36), Constr. Foreman, U. S. Dept. of Interior, ECW, 324 College Ave., Ithaca, N.Y.

NOLEN, JERRY AFTEN (Jun. '36), Draftsman, Plans and Survey Dept., State Highway Comm. (Res., 1012 West 6th St., Apartment D), Little Rock, Ark.

PASQUARIELLO, ARMAND JOSEPH (Jun. '35), 34 Cutler St., Newark, N.J.

RHODES, BYRON LESLIE (Jun. '35), 115 North Center St., Bradford, Pa.

RIEGELHUTH, WALTER MELVIN (Jun. '35), 426 Eighteenth Ave., San Francisco, Calif.

ROBBINS, STANLEY EMERSON (Jun. '36), 47 Pine Ridge Rd., Arlington, Mass.

ROEHRIG, HAROLD AUGUST (Jun. '35), U. S. Lighthouse Depot, Ft. of Mt. Elliott Ave., Detroit, Mich.

SACKETT, GUY WOODFORD, JR. (Jun. '35), 3533 Eighty-Third St., Jackson Heights, N.Y.

SAX, ALEXANDER (Jun. '36), Engr., U. S. Coast and Geodetic Survey, Princeton (Res., 400 West Blancke St., Linden), N.J.

SHADBURN, MORRIS LUTHER (M. '36), Senior Res. Engr., State Highway Board (Res., 414 Forest Ave.), Macon, Ga.

SHEAHAN, RICHARD DAVID THOMAS (Jun. '35), 32 Lake St., Brooklyn, N.Y.

SHELLEY, LEVIE HIGHTOWER (Assoc. M. '36), Alabama Representative, Dixie Culvert & Metal Co., Atlanta, Ga.

SMEDEGAARD, MAURICE GODFRED (Jun. '35), 2570 Grape St., Denver, Colo.

STORY, JESSE WILLIS (Jun. '35), Junior Instru-

TOTAL MEMBERSHIP AS OF APRIL 9, 1936

Members	5,713
Associate Members	6,190
Corporate Members	11,903
Honorary Members	19
Juniors	3,209
Affiliates	95
Fellows	2
Total	15,228

entman, State Highway Comm., Box 55, ranklinton, La.

Ward, **William Clyde** (Jun. '35), With CCC, Dist. I Supply Co., Fort Moultrie, S.C. (Res., Route 1, Adairsville, Ga.)

Weikal, **James Kenneth** (Jun. '35), Clark, Pa.

Whitehead, **William James** (Jun. '36), 3606 West 148th St., Cleveland, Ohio.

Wood, **Melville Cronkrite** (Jun. '35), Sag Harbor, N.Y.

Wood, **Robert Julian** (Assoc. M. '36), Dist. Engr., Am. Inst. of Steel Constr., Inc., 818 Olive St., Room 1405, St. Louis, Mo.

Zilly, **Herbert Carl** (Jun. '35), 618 Fifth Ave., Aurora, Ill.

Membership Transfers

Beckwith, **Charles Seward** (Jun. '28; Assoc. M. '36), Chf. Draftsman and Mech. Designer, Endicott Johnson Shoe Corporation, 536½ Central St., Endicott, N.Y.

Bogart, **John Alleyn Calhoun** (Jun. '31; Assoc. M. '36), San Engr., Florida Emergency Relief Administration, Eng. Dept, WPA, Key West, Fla.

Dornblatt, **Bernhard** (Jun. '30); Assoc. M. '35), Field Engr., Portland Cement Assoc., Box 254, New Orleans, La.

Fairbairn, **Edwin Alexander** (Jun. '29; Assoc. M. '36), Deputy County Engr., Sacramento County R. F. D. 5, Box 130, Sacramento, Calif.

Holgren, **Philip Grant** (Jun. '30; Assoc. M. '35), City Engr.'s Office, 401 City Hall (Res., North 4719 Post St.), Spokane, Wash.

Jones, **Benjamin Earl** (Jun. '09; Assoc. M. '14; M. '36), Chf., Water and Power Div., Conservation Branch, U. S. Geological Survey (Res., 3611 Military Rd., N.W.), Washington, D.C.

Legris, **Charles Ernest** (Assoc. M. '23; M. '36), Constr. Engr., U. S. Treasury Dept., Procurement Div., Northfield, Minn.

Lewis, **Ralph Webster** (Jun. '26; Assoc. M. '36), Sales Representative, The National Silk Co., Inc., South Coventry, Conn. (Res., 1116 Randolph St., Oak Park, Ill.)

Mayer, **Edward Bromley** (Assoc. M. '27; M. '36), Executive Asst. to Gen. Mgr. and Chf. Engr., Bureau of Water Works and Supply (Res. 933 West 53d St.), Los Angeles, Calif.

Reed, **Royden Eugene** (Assoc. M. '29; M. '36), State Engr. Insp., PWA for Kansas and Oklahoma, 641 New England Bldg., Topeka, Kans.

Saeng-Xuto, **Sra Mongkala** (Jun. '24; Assoc. M. '35), Chf. Maintenance Engr., Div. of Ways, Dept. of Public and Municipal Works (Res., 855 Pramuan Rd.), Bangkok, Siam.

Sethmann, **Martin William** (Jun. '32; Assoc. M. '36), Asst. Engr. of Constr., Dept. of Sanitation, WPA (Res., 1717 Gates Ave.), Brooklyn, N.Y.

Vagtborg, **Harold Alfred** (Jun. '27; Assoc. M. '34), Cons. Engr. (Vagtborg & Associates, Inc.); Asst. Prof., Municipal and San. Eng., Armour Inst. of Technology, 3300 Federal St., Chicago, Ill.

Youmans, **George Leland** (Jun. '13; Assoc. M. '17; M. '36), Dist. Mgr., Morrison-Knudsen Co., Inc., Box 237, Blue Island, Ill.

Reinstatements

Bennett, **Evan Harold**, Assoc. M., reinstated March 12, 1936.

Kehoe, **James Luke**, Affiliate, reinstated April 2, 1936.

Long, **George Vilas**, Assoc. M., reinstated April, 2, 1936.

Mead, **Royal Lee**, Assoc. M., reinstated April 6, 1936.

Potter, **William Dayton**, Assoc. M., reinstated March 24, 1936.

Sharp, **Josiah Roscoe**, Assoc. M., reinstated March 16, 1936.

Resignations

Fisher, **William**, Jun., resigned March 26, 1936.

Simons, **Edward Widman**, Jun., resigned March 17, 1936.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

May 1, 1936 Number 5

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

Ackerman, **Jerome Otto**, St. Paul, Minn. (Age 27.) Associate Engr., being Office Asst. (Constr. Dept.) to Area Engr., U. S. Engr. Office. Refers to E. F. Brownell, E. J. Christenson, A. J. Duvall, G. O. Guesmer, H. M. Hill, J. L. Southworth, L. G. Straub.

Adams, **Robert Francis**, Wellington, Kans. (Age 23.) Engr., Sumner County Eng. Dept. Refers to L. E. Conrad, M. W. Furr, L. V. White.

Araneo, **Anthony Theobold**, New York City. (Age 22.) Refers to W. Allan, R. E. Goodwin, F. O. X. McLoughlin, W. L. Willig.

Bailey, **Williams Dunlavy**, Amityville, N.Y. (Age 35.) Civ. Engr., Long Island State Park Comm. (under TERA and WPA). Refers to L. G. Holleran, A. E. Howland, W. K. Koch, C. B. Lindholm, S. Shapiro.

Bates, **William Jourdan**, Wheeling, W.Va. (Age 24.) With Consolidated Expanded Metal Companies. Refers to E. J. Costello, Jr., R. Hazlett, R. B. Smith.

Berg, **Louis Leighty**, Ludington, Mich. (Age 25.) Development and Service Engr., Elec. Tamper & Equipment Co. Refers to J. Berg, F. M. Dawson, H. F. Janda, L. F. Van Hagan.

Blauvelt, **John Irving**, Little Falls, N.J. (Age 31.) Chf. Engr., Warren and Arthur Smadbeck, Inc., New York City. Refers to F. O. Dufour, M. Hendee, C. MacDonald, C. H. Splitstone, W. Wickstrom.

Buchanan, **George Henry**, Washington, D.C. (Age 47.) With Procurement Div., PWA

Branch, Treasury Dept. Refers to W. E. Belcher, A. E. Duckwall, C. H. Field, T. B. Rights, C. A. Wilmore.

Buffum, J. Sayles, New York City. (Age 44.) Asst. Civ. Engr., Transit Comm. Refers to F. J. Biele, H. Grand, W. K. Koch, S. Rosenberg, S. Shapiro.

Buzzell, Dow Alan, Hastings, Nebr. (Age 42.) Chf. Design Engr., Tricounty (power and irrigation) Project. Refers to A. W. Andrews, F. T. Darrow, H. A. Foster, E. E. Halmos, J. P. Hogan, J. G. Mason, D. B. Steinman.

Calvin, Clyde Burrell, Akron, Ohio. (Age 36.) Staff Engr. and Draftsman, Firestone Tire & Rubber Co. Refers to M. L. Davis, W. H. Dittoe, G. G. Dixon, O. R. Elting, E. A. Kemmler, K. W. Ponsy, E. L. Winslow, Jr.

Cavendish, Lynn Ray, South Charleston, W.Va. (Age 36.) Senior Engr., West Virginia State Road Comm. Refers to E. N. Blackwood, H. A. Levering, J. T. Moore, C. M. Ross, M. W. Smith, Jr., P. J. Walsh.

Clarridge, Charles Evans, Potsdam, N.Y. (Age 28.) Instructor, Civ. Eng. Dept., Clarkson Coll. of Technology. Refers to W. H. Allison, W. J. Farrisee, F. C. Wilson.

Colosimo, Henry, Ozone Park, N.Y. (Age 38.) Asst. Engr. of Constr., Emergency Work Bureau, Dept. of Health. Refers to A. A. A. Carman, A. Freihofner, M. E. Milone, G. H. Peters, G. M. Purver.

Corley, Robert Hare Powel, Philadelphia, Pa. (Age 50.) Div. Engr., Philadelphia Rapid Transit Co. Refers to J. H. M. Andrews, F. W. Gardiner, W. I. Lex, L. F. Parlette, W. R. Scanlin, C. H. Stevens.

Costinett, John Harrison, Aberdeen, Md. (Age 22.) Under Eng. Aide, U. S. Govt., Aberdeen Proving Grounds. Refers to A. N. Johnson, S. S. Steinberg.

Cronkright, Arthur Bradford, Arlington, N.J. (Age 24.) Refers to G. M. Fair, A. Haertlein.

Cushing, Paul Joseph, Oakland, Calif. (Age 25.) Vice-Pres. and Treas., also Div. Engr., Hydraulic Dredging Co., Ltd. Refers to J. E. Cahill, E. I. Clawiter, A. J. Hammond, J. H. Polhemus, O. G. Stanley.

Dastoli, Theodore, Lowellville, Ohio. (Age 26.) Refers to R. P. Davis, W. S. Downs.

Donley, David Edward, Knoxville, Tenn. (Age 33.) Associate Hydr. Engr., TVA. Refers to J. S. Bowman, A. S. Fry, W. T. Howe, J. H. Kimball, G. H. Matthes, S. M. Woodward, G. R. Young.

Drought, Francis Tunstall, San Antonio, Tex. (Age 33.) 1st Lieut., Engr.'s Reserve; Lilly & Drought, Cons. Engrs. Refers to A. R. Alling, C. T. Bartlett, H. R. F. Helland, W. H. Lilly, G. R. Lukesh, E. W. Robinson, W. H. Waugh.

Durrant, Theodore Vincent Scott, London S.W. 7, England (Age 33.) 1st Tech. Asst., Banstead, Urban Dist. Council, Surrey. Refers to C. B. Breed, C. M. Spofford. (Applies in accordance with Sec. 1, Art. I, of the By-Laws.)

Gareis, Charles Augustus, Baltimore, Md. (Age 30.) In private practice. Refers to P. G. Crout, E. Mowlds, J. M. Russell, C. H. Tompkins, W. M. Wolfe.

Gitter, Lester Jonas, Brooklyn, N.Y. (Age 20.) Refers to W. Allan, F. O. X. McLoughlin.

Goldenberg, Joseph William, Springfield, Ill. (Age 25.) Asst. Highway Engr., Bridge Office, Illinois Div. of Highways. Refers to G. F. Burch, F. R. Friedewald, B. C. McCurdy, P. Z. Michener, C. E. Morgan, W. N. Schroeder, L. T. Wyly.

Grant, John William, Pittsburgh, Pa. (Age 28.) Chf. Engr. of Design and Constr., Atlas Mineral Products Co. Refers to W. A. Conwell, B. T. Gordon, C. E. Portas, G. S. Richardson, C. B. Stanton, H. A. Thomas.

Haase, John Aloysius, III, New Orleans, La. (Age 25.) Buyer, Purchasing Depts., ERA, FERA, and U. S. Treasury Dept. Refers to D. Derickson, A. J. Negrotto.

Hallquist, Stone Conrad, Milwaukee, Wis. (Age 34.) With PWA as Supt. of Constr. on project ($500,000) in Parktown Area. Refers to F. B. Hatton, E. L. Pflanz, S. M. Siesel, C. S. Whitney, G. R. Young.

Harvey, Count, Denver, Colo. (Age 46.) Associate Engr., U. S. Bureau of Reclamation. Refers to F. B. Cook, Jr., J. T. N. Hoyt, G. McFadden, D. A. Molitor, R. A. Monroe, F. J. Nebiker, C. Sacra, N. K. Sheppard.

Hasell, Philip Gadsden, Columbia, S.C. (Age 35.) Asst. State Director of Malaria Control, U. S. Public Health Service. Refers to H. Beebe, A. Epstein, L. M. Fisher, J. E. Gibson, J. M. Jarrett, A. E. Johnson, W. G. Jones, L. W. Pollard, W. E. Rowe, R. L. Sumwalt, W. W. Wannamaker, Jr.

Hawley, Harry Holman, Columbus, Ohio. (Age 37.) Designing Engr., Grade III, Bureau of Bridges, Dept. of Highways. Refers to B. F. Hatch, W. H. Knox, R. R. Litehiser, C. T. Morris, J. R. Shank, W. G. Smith, R. N. Waid.

Hayes, John Joseph, Boston, Mass. (Age 66.) Inspector, Bridge & Ferry Div. Refers to O. H. Horovitz, T. H. Keenan, A. J. Post, H. C. Sheils, D. M. Sullivan.

Hooper, Lewis Gladstone, New Orleans, La. (Age 54.) Member of firm, Swanson-McGraw-Hooper, Cons. Engrs. Refers to J. F. Coleman, J. T. Eastwood, A. M. Fromherz, E. L. Jahncke, O. K. Olsen, A. M. Shaw, J. A. L. Waddell.

Horridge, John, Philadelphia, Pa. (Age 50.) Engr., Porter Gildersleeve Corporation. Refers to D. T. Corning, J. E. Gill, C. H. Hitchcock, S. H. Knight, C. E. Myers, J. H. Neeson, F. G. Schworm, C. S. Shaughnessy.

Huie, Samuel Sze Lien, New York City. (Age 25.) Rodman, Marine Parkway Authority, Madigan-Hyland, Cons. Engrs. Refers to W. Allan, R. E. Goodwin, F. O. X. McLoughlin.

Imrey, Leon Sidney, New York City. (Age 29.) With Dept. of Water Supply, Gas & Electricity. Refers to J. E. Beswick, T. M. Burns, J. Goodman, W. Hauck, W. M. Paddock, C. T. Schwarze.

Jennings, Jeremiah Edmund Bowden, Cambridge, Mass. (Age 23.) Graduate student, Massachusetts Inst. of Technology. Refers to H. K. Barrows, G. Gilboy, K. C. Reynolds, C. M. Spofford, W. G. Sutton, J. B. Wilbur.

Judd, Leon W., Balboa Heights, Canal Zone. (Age 48.) With Sec. of Office Engr., The Panama Canal. Refers to M. R. Alexander, P. Andersen, B. J. Fletcher, R. C. Jones, F. R. Molther, L. B. Moore, E. S. Randolph.

Kenney, Norman Durling, Baltimore, Md. (Age 32.) Draftsman, Designer, Valuation Asst., and Computer, Whitman, Requardt & Smith, Cons. Engrs. Refers to F. A. Barnes, H. R. Leach, G. J. Requardt, M. E. Scheidt, B. L. Smith, S. L. Thomsen, E. B. Whitman, A. Wolman.

Layne, Arthur Robert, San Francisco, Calif. (Age 25.) Refers to C. Derleth, Jr., B. A. Etcheverry.

Leach, Laurence Gay, East Cleveland, Ohio. (Age 25.) U. S. Engrs., Zanesville, Ohio under Res. Engr. of Leesville (Ohio) Dam. Refers to G. E. Barnes, M. S. Douglas.

Lienhard, Frederick, New York City. (Age 37.) Engr. with Leon S. Moisseiff, Cons. Engr. Refers to O. H. Ammann, G. E. Beggs, C. Derleth, Jr., G. L. Freeman, S. Hardesty, L. S. Moisseiff, C. S. Proctor.

Lingo, Robert Myron, Topeka, Kans. (Age 22.) Refers to E. Boyce, G. W. Bradshaw.

MacDonald, Harold Joseph, Cambridge, Mass. (Age 41.) With Colonial Beacon Oil Co., Boston, Mass. Refers to R. A. Backus, C. B. Breed, C. M. Spofford, J. T. Whitney, J. H. Whitney.

McMillin, Frederick William, Jr., Buffalo, N.Y. (Age 35.) Sales Engr., Federal Portland Cement Co., Inc. Refers to I. V. A. Huie, S. S. Neff, R. M. Rumsey, E. G. Speyer, A. F. Underhill.

Martin, Paul Gordon, Topeka, Kans. (Age 39.) Asst. Office Bridge Engr., Kansas Highway Comm. Refers to B. Boyle, W. V. Buck, L. E. Conrad, O. J. Eidmann, C. H. Scholer.

Means, Raymond Ellsworth, Stillwater, Okla. (Age 42.) Asst. Prof. of Architecture, Oklahoma Agricultural and Mechanical Coll. Refers to H. Cross, P. M. Geren, W. C. Huntington, R. O. Jameson, J. E. Kirkham, E. R. Stapley.

Meissner, Harmon Stimbert, Denver, Colo. (Age 36.) Associate Civ. Engr., U. S. Bureau of Reclamation. Refers to J. J. Hammond, C. A. Hoglund, A. Ruettgers, J. L. Savage, R. A. See, B. W. Steele, H. W. Tabor.

Packard, Frank, Sacramento, Calif. (Age 39.) Jun. Topographical Engr., Conservation Branch, U. S. Geological Survey. Refers to L. L. Bryan, J. W. Gross, H. H. Hodgeson, N. Silsbee, F. D. Talbot, T. B. Waddell, D. R. Warren.

Page, John Chatfield, Chevy Chase, Md. (Age 48.) Chf., Eng. Div. (Eng. Asst. to Commr.), U. S. Reclamation, Washington, D. C. Refers to A. H. Ayers, F. T. Crowe, S. O. Harper, F. Thomas, R. F. Walter, F. E. Weymouth, W. R. Young.

Palmer, Aubrey Edwin, Roanoke, Va. (Age 23.) Student Engr., U. S. Bureau of Public Roads. Refers to W. M. Austin, J. L. Newcomb.

Peller, Joseph Paul, North Tarrytown, N.Y. (Age 36.) Eng. Inspector of pier construction, Dept. of Docks, New York City. Refers to T. R. Galloway, A. G. Hayden, J. R. Losee, L. R. Newhall, J. W. Van Denburg, W. H. Yates.

Phelan, James, New York City. (Age 29.) Senior Topographical Draftsman. Dept. of Parks, Manhattan Topographical Div. Refers to F. E. Foss, M. E. Milone, G. H. Peters, M. H. Van Buren, J. P. J. Williams.

Pitcher, Bernard Marley, Washington, D.C. (Age 32.) Structural Engr., Constr. Div., Resettlement Administration, U. S. Govt. Refers to H. W. Bressler, E. A. Greey, W. A. Hitchcock, C. C. Singleton, L. W. Weed.

Ramirez de Arellano, Frank, San Juan, Puerto Rico. (Age 25.) Asst. Engr. with Carlos del Valle Zeno, Cons. Engr. Refers to J. Benitez-Gautier, J. V. Davila, E. S. Jimenez, R. Skerett-Landron, J. Urbino, C. del Valle Zeno.

Raphael, Jerome Maurice, Grafton, W. Va. (Age 23.) Inspector, U. S. Engrs., Tygart River Reservoir Dam. Refers to R. W. Carlson, J. E. Deignan.

Reed, Charles Alley, Oakland, Calif. (Age 49.) Street Improvement Engr. Refers to W. B. Boggs, W. N. Frickstad, H. F. Gray, R. S. Hawley, B. Jameyson, M. P. Kitchel, R. R. Ribal.

Robbins, Howard Edwards, Denver, Colo. (Age 39.) Associate Engr., U. S. Bureau of Reclamation. Refers to J. J. Hammond, J. R. Iakisch, E. C. Koppen, H. R. McBirney, R. Sailer, J. L. Savage, B. W. Steele.

Roberts, Verlin Alfred, Holdredge, Nebr. (Age 37.) Refers to G. N. Carter, F. T. Crowe, E. F. Haas, G. E. Johnson, C. J. McNamara, D. D. Price, G. L. Youmans.

Robinson, Delbert Walton, Ft. Worth, Tex. (Age 36.) Water and Gas Engr., Community Public Service Co. Refers to E. L. Filby, J. J. Hinman, Jr., J. Rady, R. W. Reynolds, J. R. Tanner, E. L. Waterman.

Saint, Frederick Gilman, Ft. Belvoir, Va. (Age 27.) 1st Lieut. C.E.; student, The Engr. School, U. S. Army. Refers to G. E. Beggs, F. H. Constant.

Schwartzman, Nathan, Lexington, Ky. (Age 25.) Draftsman, Central Office Drafting Room, Kentucky State Highway Dept. Refers to W. J. Carrel, H. R. Creal, W. W. Sanders, E. D. Smith, D. V. Terrell, W. S. Todd.

Scoular, Spencer Gray, Dunedin, N.W. 1, New Zealand. (Age 40.) Personal (principal) Asst. to City Engr. and Deputy Drainage Engr., City Engrs. Dept., Dunedin, and Eng. Dept., Dunedin Drainage & Sewerage Board. Refers to C. A. Lee, R. W. Parkhurst, A. Tyndall. (Applies in accordance with Sec. 1, Art. I, of the By-Laws.)

Slezak, Edward John, New York City. (Age 27.) Chf. of Party on topographical survey, with Park Dept. Refers to F. A. Barnes, L. C. Urquhart.

Smith, Preston Clark, Alexandria, Va. (Age 21.) Student Engr. (highway), Bureau of Public Roads, Washington, D.C. Refers to G. P. Boomsliter, L. V. Carpenter, R. P. Davis, W. S. Downs, C. A. Hogentogler.

Streander, Philip Bertram, New York City. (Age 46.) Associate Engr. with George L. Watson, Cons. Engr. Refers to H. B. Cleveland, W. Donaldson, C. A. Emerson, Jr., L. H. Enslow, P. Hansen, G. D. Holmes, C. E. Myers, A. Potter, I. S. Walker, G. L. Watson.

Summers, Reuel, Hastings, Nebr. (Age 39.) Office Engr. to Chf. Engr. and Gen. Mgr., The Nebraska Central Public Power and Irrigation Dist. Refers to J. A. Bruce, R. O. Green, G. E. Johnson, C. C. Nicholls, J. Sorkin, C. E. Spellman.

Sutphin, Bertram Harrison, Jr., Brooklyn, N.Y. (Age 23.) Refers to G. J. Davis, Jr., J. S. Leister.

Tellepsen, Howard Tellef, Houston, Tex. (Age 23.) Estimator, Tellepsen Constr. Co. Refers to R. P. Black, R. J. Cummins, F. C. Snow.

Thornley, Joseph Harry, Chicago, Ill. (Age 48.) Pres. and Chf. Engr., Western Foundation Co. Refers to T. L. Condron, R. P. Durham, H. D. Loring, C. L. Post, G. B. Sowers, F. B. Spencer.

Tyler, Bert Richard, East Point, Ga. (Age 29.) Chf. Draftsman, Golian Steel & Iron Co. Refers to E. F. Chobot, J. T. Garrett, C. E. Maxfield, J. E. Morelock, C. R. Tiebout.

Updegrove, Jacob Walter, Easton, Pa. (Age 23.) Draftsman, Lehigh Valley R.R., Bridge Engr.'s Office. Refers to W. S. Lohr, L. Perry, H. T. Rights, E. H. Rockwell.

Wilcox, Halsted Newell, Takoma Park, D.C. (Age 33.) Bridge Draftsman, Baltimore & Ohio R.R. Refers to F. A. Barnes, A. P. Bursley, W. Z. Kline, C. A. Knowles, P. G. Lang, Jr., J. J. Manning, C. E. Sloan.

Wilkinson, Read Arthur, Burlington, Kans. (Age 24.) Engr., SCS, ECW, No. 7, Burlington, Kans., U. S. Dept. of Agriculture. Refers to V. L. Austin, E. D. Dake.

Williamson, Frank Martin, Chicago, Ill. (Age 34.) Asst. Civ. Engr., San. Dist. of Chicago. Refers to N. E. Anderson, W. H. Ashley, H. E. Babbitt, M. L. Enger, L. Pearse, H. P. Ramey, L. C. Whittemore.

Willis, Charles Leyton, Jr., Dallas, Tex. (Age 31.) Special Agent-Engr., Div. of Investigations, PWA. Refers to R. J. Cummins, H. E. Elrod, G. W. Gill, J. H. Knox, J. Montgomery, G. C. Street, Jr., A. Tamm, W. M. Wilson.

Wolfgang, John Leonard, New York City. (Age 29.) Refers to D. J. Cloward, D. M. Griffith, N. J. Hainovsky, G. D. Munch, P. H. Myers.

Woolsey, Walter Benjamin, New York City. (Age 42.) Director of Bldg. Mgt. & Supply Div., ERB. Refers to J. W. F. Bennett, D. G. Edwards, J. P. H. Perry, E. Praeger, O. Singstad, W. J. Wilgus.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

Cady, Ralph Howe, Assoc. M., New York City. (Elected July 9, 1923.) (Age 42.) Engr. and Foreign Representative, Frederick Snare Corporation. Refers to A. J. Decker, O. M. Jones, F. J. Litter, G. P. Seeley, Jr., E. S. Skillin.

Ellis, Robert Richardson, Jr., Assoc. M., Cartagena, Colombia, S.A. (Elected Nov. 12, 1928; Assoc. M., Feb. 10, 1930.) (Age 35.) Asst. Engr. and Office Mgr., Frederick Snare Corporation. Refers to A. M. Alvarez y de Urrutia, M. J. Backus, H. L. Bowman, F. J. Litter, G. P. Seeley, Jr., C. M. Spofford, C. H. Sutherland.

English, Charles Carmen, Assoc. N., Cleveland, Ohio. (Temporary address, United Fruit Co., Banes, Cuba.) (Elected Junior Nov. 26, 1923; Assoc. M. Jan. 16, 1928.) (Age 36.) Civ. Engr., United Fruit Co. Refers to W. T. Barnes, C. H. Bryson, J. W. Ellms, J. W. Frazier, B. M. Jones, J. E. A. Linders, W. W. Schuyler, R. E. Sheal.

Friedman, Edmund, Assoc. M., Miami, Fla. (Elected March 14, 1927.) (Age 38.) County Engr., Dade County, Fla. Refers to A. S. Craven, M. B. Garris, M. N. Lipp, C. S. Nichols, W. I. Nolen, C. A. Renshaw.

Gardiner, John Haines, Assoc. M., Ft. Smith, Ark. (Elected Junior May 28, 1923; Assoc. M. July 12, 1926.) (Age 41.) (Hydr. Engr and Dist. Engr., U. S. Geological Survey, Water Resources Branch. Refers to C. E. Boesch, J. C. Carpenter, W. D. Dickinson, N. C. Grover, J. C. Hoyt, C. G. Paulsen.

Gwathmey, William Watts, Jr., Assoc. M., Grafton, W.Va. (Elected Assoc. M. Jan. 19, 1925.) (Age 47.) Asst. Engr., Baltimore & Ohio R.R. Refers to H. H. Allen, H. A. Lane, P. G. Lang, Jr., R. Mather, L. Schaidt, E. Stimson.

Hefling, Arthur William, Assoc. M., Hutchinson, Kans. (Elected July 12, 1930.) (Age 37.) Gen. Mgr. and Chf. Engr., The Hefling & Hughes Eng. Co. Refers to W. E. Baldry, J. C. Bisset, W. R. Fithian, R. L. Hockett, W. C. McNown, M. C. Nichols, J. O'Neil, H. Tidd.

Howes, Herbert Ellsworth, Assoc. M., Portland, Ore. (Elected March 2, 1915.) (Age 55.) Asst. Regional Engr., Region 6, U. S. Forest Service. Refers to C. C. Babb, E. D. Burchard, C. N. Conner, J. Frankland, T. W. Norcross, J. I. Parcel, C. M. Upham.

Jessup, Albert Hall, Assoc. M., San Gabriel, Calif. (Elected July 11, 1927.) (Age 49.) Designing Engr., Quinton, Code & Hill-Leeds & Barnard, Cons. Engrs., Los Angeles, Calif. Refers to W. H. Code, L. C. Hill, W. E. Jessup, H. M. Jones, R. J. Reed, O. A. Stone.

Pool, Charles Lundy, Assoc. M., Providence, R.I. (Elected Aug. 4, 1924.) (Age 39.) San. Engr. and Chemist, Rhode Island Dept. of Public Health. Refers to J. H. Caton, 3d, E. S. Chase, G. M. Fair, L. M. Fisher, W. J. Scott, F. E. Waterman, A. D. Weston, R. S. Weston, F. C. Williams, A. Wolman.

From the Grade of Junior

Burgess, George Van Trump, Jun., Tuckahoe, N.Y. (Elected Oct. 10, 1927.) (Age 33.) Gen. Mgr., Eastern Service Studios, Inc., New York City. Refers to W. C. Bodycomb, H. W. Buck, G. W. Burpee, A. G. Chapman, J. H. S. Melville.

Campbell, Philip, Jr., Jun., Port Arthur, Tex. (Elected March 5, 1928.) (Age 32.) Chf. Draftsman, The Texas Co. Refers to D. Derickson, J. de Tarnowsky, M. Halpern, R. L. Moroney, P. H. Myers, H. A. Smith.

Christiansen, Jerald Emmett, Jun., Davis, Calif. (Elected Oct. 1, 1928.) (Age 31.) Jun. Irrigation Engr., Experiment Station, Coll. of Agriculture, Univ. of California. Refers to J. B. Brown, C. Derleth, Jr., B. A. Etcheverry, O. W. Israelsen, M. P. O'Brien, H. B. Walker.

Cohen, Paul Arthur, Jun., Baltimore, Md. (Elected Dec. 5, 1927.) (Age 32.) Asst. Engr., Bridge Div., Bureau of Highways, Baltimore. Refers to B. L. Crozier, H. F. Doeleman, F. K. Duncan, T. F. Hubbard, O. H. Schroedl, J. T. Thompson.

Connington, Charles Simpson, Jun., Pelham Manor, N.Y. (Elected March 14, 1927.) (Age 32.) Sales Engr., Reilly Tar & Chemical Corporation, New York City. Refers to H. E. Breed, A. Haring, L. P. Hover, J. J. Loeser, R. N. Miller, C. T. Schwarze, W. Summers.

Faigle, John Emil, Jun., Portsmouth, Va. (Elected Oct. 26, 1931.) (Age 32.) Asst. to Public Works Officer, U. S. Navy. Refers to F. C. Bedell, C. H. Cotter, J. J. Gromfine, P. L. Reed, R. E. Thomas, D. C. Webb.

Guinn, Rembert Shields, Jun., Austin, Tex. (Elected Oct. 14, 1929.) (Age 32.) Asst. Engr., Bridge Div., Texas State Highway Dept. Refers to E. C. H. Bantel, W. M. Eliot, J. P. Exum, J. A. Focht, E. E. Pittman, G. G. Wickline.

Hoffberg, William Arnold, Jun., New York City. (Elected July 11, 1927.) (Age 32.) Refers to W. Ginsberg, R. E. Goodwin, M. Henry, W. H. Hunt, F. O. X. McLoughlin, H. C. Riesbol.

Kimbrough, Clyde William, Jun., Bonneville, Ore. (Elected Oct. 26, 1931.) (Age 32.) Prin. Draftsman, Corps of Engrs., U. S. Army, Bonneville Dam Project. Refers to A. Bauer, V. Gongwer, G. E. Goodwin, M. K. Snyder, R. K. Tiffany, B. E. Torpen.

Kirby, Herman Estel, Jun., Richmond, Va. (Elected Nov. 15, 1926.) (Age 32.) Asst. Cost Engr., The Chesapeake & Ohio Ry. Co. Refers to L. B. Allen, J. A. Hammack, C. W. Johns, C. R. Knowles, J. A. Parant, F. S. Schwinn, E. E. Snyder, J. E. Teal.

Lind, Herbert William, Jun., Brooklyn, N.Y. (Elected Jan. 13, 1930.) (Age 32.) Transitman, New York Central R.R., New York City. Refers to A. M. Anderson, A. W. Carpenter, W. N. Hazen, W. F. Steffens, W. L. Unger.

Niederman, Philip Henry, Jun., Oak Park, Ill. (Elected July 16, 1928.) (Age 33.) Asst. Gen. Supt., Great Lakes Dredge and Dock Co. Chicago, Ill. Refers to J. E. Cahill, O. P. Erickson, W. P. Feeley, J. F. Seifried, S. M. Siesel, L. F. Van Hagan.

Paulet, Emile George, Jun., Baton Rouge, La. (Elected Jan. 16, 1928.) (Age 28.) Bridge Design Engr., Louisiana Highway Comm. Refers to W. G. Grove, H. H. Honk, N. E. Lant, B. W. Pegues, H. D. Robinson, H. C. T. Toensfeldt, C. Weiss.

Pearson, Theo Porter, Jun., Myrtle Beach, S.C. (Elected Aug. 15, 1932.) (Age 32.) With Standard Dredging Co., New York City as Mgr. at Myrtle Beach, S.C. Refers to W. S. Fitzsimons, W. F. Lineberger, G. W. Sackett, M. J. Young, G. A. Youngberg.

Retzke, Paul Otto, Jun., Omaha, Nebr. (Elected Oct. 1, 1928.) (Age 32.) Asst. Civ. Engr., Quartermaster Corps, U. S. Army. Refers to J. O. Davis, L. S. Doten, L. Mitchell, S. D. Sarason, J. A. Wahler.

Singh, Lal, Jun., Rangoon, Burma, India. (Elected Nov. 10, 1930.) (Age 32.) Res. Engr., Burma Corporation, Ltd., Namtu, Burma. Refers to A. A. Brielmaier, H. Cross, W. C. Huntington, F. E. Richart, J. S. Worley.

Wallace, Gordon, Jun., New York City. (Elected Nov. 23, 1931.) (Age 30.) Chf. Eng. Draftsman, Public Works Dept., Third Naval Dist. Refers to A. Dick, F. E. Foss, M. Ketchum, G. F. Reeves, H. J. Rover, J. P. J. Williams.

Wark, James Evert, Jun., Ann Arbor, Mich. (Elected Dec. 14, 1925.) (Age 33.) Engr. with Ayres, Lewis, Norris & May. Refers to L. E. Ayres, G. H. Fenkell, E. A. Hardin, W. C. Hoad, A. B. Morrill, J. W. Orton.

FROM THE GRADE OF AFFILIATE TO ASSOCIATE MEMBER

Kehoe, James Luke, Affiliate, Newburgh, N.Y. (Elected Nov. 14, 1927.) (Age 55.) Zone Mgr., and Project Engr., WPA, Goshen, N.Y., Third Dist., White Plains, N.Y. Refers to H. E. Breed, F. J. Collins, T. Fenner, C. T. Fisher, C. A. Gridley, C. W. Van Dyke.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1936 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

Graduate Civil Engineer; Jun. Am. Soc. C.E.; 28; married; 6 years experience in construction, including supervision of building construction, surveying (chief of party), estimating, and drafting. Location immaterial. D-379.

Civil and Construction Engineer; Jun. Am. Soc. C.E.; Louisiana State license; 29; married; B.E., Tulane University; 5 months structural steel detailer; 1 year transitman, surveys and construction; 6 years assistant engineer in charge surveys, inspection, and construction. Desires permanent position. Excellent references. Available now. D-3676.

Civil and Construction Engineer; Jun. Am. Soc. C.E.; 28; single; B.S. in C.E., 1930; over 4 years experience in concrete highway and bridge design and construction; road construction; miscellaneous buildings and structures; surveying; with state, city, park commission, and contractor; now employed; available on short notice. D-4844.

Civil Engineer; Jun. Am. Soc. C.E.; 36; single; B.S. in C.E., 1932, University of North Carolina; 1 year (maintenance) railway engineering; 3 years highway location; surveys as assistant party chief; 6 months plane-table work; 3 months on city surveying; 5 months drafting, state and county maps. Estimates. Prefers position with future with a private construction company. Location immaterial. Available one month's notice. D-4852.

DESIGN

Civil Engineer; Jun. Am. Soc. C.E.; B.S. L.L.B.; highway, railroad, and bridge surveying 5 months; topographical surveying, computing, and drafting, $2^1/_2$ years; structural designing, drafting, and estimating reinforced concrete and steel and alignments for subway and elevated work, $3^1/_2$ years; teaching mathematics, science, and drafting, 5 years. B-9342.

EXECUTIVE

Hydraulic and Structural Engineer; Assoc. M. Am. Soc. C.E.; age 33; married; graduate; 12 years experience on investigation, surveys, design, estimate, construction, and maintenance of large and small hydro-electric developments, domestic and foreign. Desires connection with power company. Available on reasonable notice. C-3752.

Civil Engineer; M. Am. Soc. C.E.; age 41; now available; civil engineering graduate, Massachusetts Institute of Technology; 11 years experience as foreman, superintendent, and construction engineer on sewers, tunnels, subways, harbor work, earthwork, surveys; 3 years stadia; some knowledge of steam and refrigeration. D-4227.

Promotion and Construction; Assoc. M. Am. Soc. C.E.; New York state license; Rensselaer Polytechnic Institute; married; 45; 13 years construction foreman, industrial design, and field engineer; 12 years fire-protection, trade-extension, building-code, and legislation expert; consultant and executive manager. Competent speaker; versatile; good address; seeks responsible position, with New York headquarters, on difficult, productive work. B-3727.

Consulting Engineer; M. Am. Soc. C.E.; Mem. A.I.E.E.; 60; single; graduate, Stanford University; 6 years as superintendent and chief engineer, hydro-electric transmission and city distribution system; 30 years experience as consulting engineer. Clients include U. S. Department of the Interior, State of California, and many municipalities and corporations specializing in power transmission systems, dams, and irrigation. D-4229-358-A-1-San Francisco.

Supervising Engineer; M. Am. Soc. C.E.; Pennsylvania state license; over 20 years in steel fabricating business—all branches of design, estimating, sales, and fabrication—and in management of general contracting business. Has had an all-round, thorough, operating and sales experience. C-5095.

JUNIOR

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; B.S. in C.E., New York University, 1933; American research fellow in structural engineering, Budapest, Hungary, 1934; M.S. in C.E., research fellow in civil engineering, Lehigh University, 1934–1936. Desires position in structural design, construction, research, or teaching. D-4806.

Recent Graduate; Jun. Am. Soc. C.E.; 23; single; C.E., Rensselaer Polytechnic Institute; 2 years graduate work on fellowship at same institution, majoring in structures. Familiar with Beggs deformeter, photo-elastic stress analysis, calculating machine. Sigma Xi. Desires summer employment in some phase of bridge or structural engineering. Location immaterial. D-4805.

Civil Engineer; Jun. Am. Soc. C.E.; $22^1/_2$; single; C.E., Rensselaer Polytechnic Institute, 1935; Sigma X; now temporarily employed by New York Park Department (under WPA) as transitman on park layout and building construction. Desires opportunity in any branch of civil engineering; prefers design or construction. Location immaterial. D-4587.

Civil Engineer; Jun. Am. Soc. C.E.; 28; single; graduate of Purdue University, highest honors; 6 years diversified experience as large structural steel fabricator. Experienced in shop fabrication, structural detailing, field erection of bridges and buildings, cost accounting, designing, estimating. Capable of handling men. Desires position with active construction or engineering organization offering opportunity for advancement. Location immaterial. D-2665.

Civil Engineer; Jun. Am. Soc. C.E.; 31; married; 2 years at Purdue University; $1^1/_2$ years at Massachusetts Institute of Technology. Experience covers responsible charge of all types of surveys (highways and bridges). Triangulation, construction, and design of highways; construction of parkways and bridges; drafting—mechanical and topographical. Available short notice. D-4475.

Civil Engineer; Jun. Am. Soc. C.E.; 24 years old; single; B.S. in C.E., Rhode Island State College. Majored in bridge design, roads, and water supply; 2 years experience as industrial engineer; 2 years experience as instructor in practical surveying. Location immaterial. Desires opportunity. Excellent recommendations. D-4567.

Civil Engineer; Jun. Am. Soc. C.E.; 22; B.S.C.E., University of Wisconsin, 1934; now designing dams for government agency; 2 years experience on hydraulic projects. Prefers position with construction contractor, or consulting engineer. Available on 15 days notice. Location and salary open. D-4866.

Civil Engineer; Jun. Am. Soc. C.E.; 23; single; Rensselaer Polytechnic Institute, 1935; 5 months experience surveying; excellent draftsman; knowledge of steam power plants; speaks, reads, and writes German fluently; desires position in any field of construction with opportunity for advancement; location immaterial. D-4816.

Civil Engineer; Jun. Am. Soc. C.E.; single; B.S. C.E., University of Illinois, 1935; 6 months experience as surveyman, New York state flood control survey; 2 summers railroad maintenance. Available immediately. Will locate anywhere. Excellent draftsman. Real capacity for hard work. D-4653.

Graduate Michigan State College, 1935; Jun. Am. Soc. C.E.; age 28; weight 200 lb; height 6 ft. Experience with U. S. Department of the Interior park service; surveying in Department of Agriculture biological U. S. survey as a junior civil engineer; design of ditches, dikes, and roads. Locality immaterial, but prefer cooler climates. Thesis: First Order Survey and Triangulation. D-4596.